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The Fifty-Sixth Meeting of the American Astronomical Society

By DEAN B. McLAUGHLIN

Meetings of the American Astronomical Society at Harvard would appear to have become a habit. The fifty-sixth meeting, however, was a special occasion, as it was held in connection with the Harvard Tercentenary celebration, and two of its sessions were a portion of the Harvard Tercentenary Conference of Arts and Sciences.

Most of those attending the meeting arrived Wednesday evening, September 2, and registered at Straus Hall, where they received assignments of rooms and "exchanged money for tickets." They were then escorted by courteous young men to rooms in various dormitories in the Harvard Yard (called the campus by most of the visitors). These rooms were generously provided by the University without charge to the visitors. One of the younger members enjoyed the distinction of occupying the room in which Nathaniel Bowditch and B. A. Gould had lived.

At the time of registration, members received a folder describing the Yard and its surroundings, and incidentally furnishing a map. With its aid and a pocket compass the writer managed to avoid losing himself, though he had several narrow escapes.

A little after nine o'clock Thursday morning the Observatory library began to fill up with handshaking astronomers. Promptly at 9:30 President Russell called the meeting to order, and President Conant of Harvard University spoke briefly in welcoming the visitors. After a few announcements the session for papers began. The office of secretary *pro-tem* was filled efficiently by J. E. Merrill. The retiring Secretary, R. S. Dugan, was unable to attend on account of illness, and his absence was regretted by all.

In place of the usual verbal warning by the presiding officer, a red light was flashed to indicate to each speaker that the time allotted to his paper had nearly expired. This device was extraordinarily successful, and its future use is strongly recommended. The mere thought of a red light seemed to scare most of the authors into presenting their papers in less than the scheduled time. The writer would suggest one improvement: instead of being at the back of the room near the lantern, the light should be somewhere *in front* where nobody could miss it.

Most of the astronomers lunched at the Union that noon, with the mathematicians. Immediately after lunch the latter departed to have their group photograph taken. How they fared is not determined, but

a heavy downpour of rain detained the astronomers for a while. Fortunately it ceased before the scheduled time of the afternoon session in the New Lecture Hall some blocks away. (The New Lecture Hall was new some thirty years ago. "New" is used in a purely relative sense.)

The Thursday afternoon session was listed in the program of the Tercentenary Conference under the mystic title "Section P2, Astrophysics." Dr. Antonie Pannekoek spoke on "The Temperature Scale of the Stars," and Dr. Russell on "The Masses of the Stars." The latter presented extensive results giving a close confirmation of the mass-luminosity relation. These longer papers were followed by "prepared remarks": by Dunham on "Temperatures and Pressures in the Atmospheres of Stars," by Saha on the ultra-violet "window" in the earth's atmosphere, and by Struve on reflection nebulae.

At 4:30 the astronomers and mathematicians were entertained by the Shapleys at a garden party at the Observatory. The lawn was partly occupied by a reconstruction of the Harvard eclipse camp at Akbulak, Siberia (apologies if misspelled). The chief instruments were known by the undignified names "Quadruped" and "Snowplow." They were constructed of gleaming Dowmetal and looked efficient and imposing, in favorable contrast to the usual assortment of stove-pipes, tin cans, and coffins associated with eclipse observations. "Yorick," a dilapidated human skull of unknown age, unearthed at Akbulak, was on exhibition near a large black tent, which some of the visitors hoped might contain a sword swallower, snake charmer, and dwarf. But the only curiosity in it was a grating which sends 75 per cent of the light into one first-order spectrum. Sooner or later everybody gravitated towards a white tent at the other end of the lawn where refreshments were served.

That evening all the astronomers except those on the Council were left to their own devices.

The Friday morning session at the Observatory was devoted entirely to papers by members of the Harvard staff, and the Society witnessed the miracle of 19 papers being presented in one session. Eleven additional papers were read by title. While the short time of presentation seemed not to damage the papers, it is a bit unfortunate that discussion was not more lively. Undoubtedly some who would have made remarks withheld them because they felt that the program was crowded.

Immediately after the session the customary group photograph was taken with a panoramic camera. The first exposure was rejected for two reasons. In the first place, the atmospheric transmission of sunlight was too variable, and in the second, two Harvardites (evidently considering two observations better than one) ran from one end of the group to the other and were recorded twice. The second exposure was more successful and involved no duplication.

The afternoon session on Friday was a joint meeting with the American Mathematical Society in the New Lecture Hall, as Section P3 of the Tercentenary Conference. Professor Levi-Civita spoke on "Astro-

nomical Consequences of the Relativistic Two-body Problem," and Sir Arthur Eddington on "The Cosmical Constant and the Recession of the Nebulae." Professor Einstein was to have had a part in the program but was unfortunately detained in Princeton by the illness of Mrs. Einstein. The papers by Levi-Civita and Eddington were followed by prepared remarks by Haas and Robertson.

At five o'clock the astronomers and mathematicians were guests of Harvard University at another tea,—this time in the Fogg Art Museum. A certain restraint characterized the astronomers, who wished to have some appetite left for the dinner.

At seven o'clock the astronomers assembled for dinner at Lowell House. On the way there the writer encountered two bewildered groups, the one trying to get out of the Yard and finding most of the gates locked, and the other hunting for the entrance to Lowell House. After nearly circumnavigating the structure (which occupies the equivalent of two city blocks) they heard the hum of voices, and this served to guide them. The Council, plus Sir Arthur and Dr. Saha, were seated at a table on a dais at the far end of the dining hall. The walls were hung with portraits of the Lowells, including Percival in full academic regalia.

After-dinner speaking seems to have died a natural death in the American Astronomical Society. On this occasion the dinner was followed by something far more interesting,—motion pictures of the pouring of the 200-inch disc, and results of the summer's work at the new solar tower of the McMath-Hulburt Observatory. Dr. Curtis furnished the "sound sequence," pointing out features of interest in both films. The solar pictures undoubtedly stole the show and were exhibited twice. They give for the first time a continuous record of prominences in action,—and there was plenty of action and "fireworks," and plenty to puzzle solar physicists, although it was rumored that a Harvard astronomer concocted an explanation within a few minutes.

The first portion of the Saturday morning session was devoted to the annual business meeting. The results of the election of officers were as follows:

Vice-President ..... R. S. Dugan
Secretary ..... J. C. Duncan
Treasurer ..... F. C. Jordan
Councilors .... S. L. Boothroyd, Keivin Burns, D. B. McLaughlin
Member, Division of Physical Sciences,
National Research Council ..... Otto Struve

A nominating committee to prepare next year's ballot was elected, consisting of P. W. Merrill, Curtis, and Fox. An Alphonse and Gaston act by Merrill and Fox concluded with the appointment of Fox as chairman. Curtis objected that he was put on that committee almost every time he came to a meeting, and he was permitted to withdraw. Pitman was elected in his place.

At the close of the business meeting appropriate resolutions were presented: one with regard to the Harvard Tercentenary, by Harper; one of appreciation to the retiring Secretary, by Slocum; and one of thanks to Harvard Observatory and to the University, by P. W. Merrill.

The remainder of the morning was devoted to the last session for papers. The program was completed sufficiently early to permit members to examine the very excellent astronomical exhibits in the Observatory before starting for the picnic at Oak Ridge observing station.

The journey to Oak Ridge was uneventful. Immediately on arrival the members were formed in a line, from which each emerged with a box of lunch and a cup of coffee. Whether he got three lunches or not was not determined, but one Harvardite succeeded in accumulating three oranges, with which he attempted a juggling act,—with variable success.

After lunch the visitors inspected the equipment. The new pyrex mirror for the 61-inch reflector was on display in the turret (there are no domes at Oak Ridge). Other instruments were the 24-inch reflector and one of the two largest objective prisms in captivity, the 16-inch and 8-inch cameras, and innumerable smaller cameras. The woods were full of them.

The inspection completed, the crowd gradually thinned. Some began their homeward journey at once, others returned to Cambridge. Through the courtesy of Miss Clara Endicott Sears, members of the Society were admitted without charge to the three museums near the village of Harvard: Fruitlands, a Shaker museum, and an Indian museum. From the hillside where they are situated there is a superb view across the Nashua River valley to Mounts Wachusett and Monadnock. The exhibits in the museums were of great interest, and the astronomers are grateful to Miss Sears and her helpers for a very instructive afternoon.

The sessions of the Society were now at an end, but the dormitory rooms could be occupied until Sunday morning, and a number of astronomers remained until then. Some also remained longer and were able to attend Sir Arthur Eddington's lecture Monday evening on "The Constitution of the Stars."

The meeting was unusually well attended. The register was signed by 147 members, which is believed to be a record. The Council admitted 27 new members, and Hisashi Kimura of the International Latitude Observatory at Mizusawa was elected an honorary member. The total membership of the Society is now 578.

The number of papers on the program was more than sixty, of which about a dozen were read by title. This is positively the saturation point (of the program, if not of the audience). The papers covered the usual wide range of subjects, and it is impossible to mention more than a few. Variable stars were rather prominent as a result of the numerous contributions from Harvard. Nine papers, from five institutions, con-

cerned Nova Lacertae, the third of the current epidemic.[1] Struve and others presented results on colors and polarization of light in reflection nebulae. Hetzler and Slipher reported the detection of a number of extremely red stars; some of Hetzler's are literally *only* red-hot. E. W. Brown found the three-body problem in star systems unexpectedly satisfactory, in that the motions are represented to a close approximation by relatively few terms. Bok and McCuskey seem to have actually succeeded, at last, in getting reasonably reliable radial velocities from objective-prism spectra. Mohler reported results of a study of solar radiation which gets through the "window" between 2000 and 2300 A. The record for presentation of papers was broken by Harper who handled eight papers from the Dominion Astrophysical Observatory.[2] Dr. Bok served very efficiently as press secretary.

The meeting was unquestionably an outstanding scientific and social success. It would be difficult to equal and impossible to surpass the hospitality shown the visitors by Harvard University and Harvard Observatory.

The fifty-seventh meeting will be held during the Christmas holidays at Hood College, Frederick, Maryland.

[1] N Oph, 1933; N Her, 1934; N Lac, 1936; N Aql, 1936.

[2] Previous records: Plaskett, 5 papers, POPULAR ASTRONOMY, **42**, 120, 1934. Adams, 5 papers, POPULAR ASTRONOMY, **43**, 78, 1935.

Highlights in the Career of Simon Newcomb*

By JAMES ROBERTSON

While attending the unveiling of the bust of Professor Newcomb at the Hall of Fame, May 28, 1936, a number of people wanted to know, more explicitly than they could gather from the addresses, just what preeminent thing Newcomb did that entitled him to a place in the Hall of Fame. This, in addition to the fact that, at the time of his death and since, I have read a number of articles in commemoration of his life, none of which seemed to stress sufficiently some of his most remarkable traits, prompted me to prepare this article. With this purpose in view, it is only necessary to mention those events that stand out as landmarks in his career.

He was born at Wallace, Nova Scotia, March 12, 1835.

From books left by his ancestors as heirlooms, he had acquired at an early age a considerable knowledge of mathematics, astronomy, and navigation.

Newcomb had an analytical and investigating mind. Before he had reached his twentieth year he had made a careful analysis of his own

*Communicated by Captain J. F. Hellweg, U. S. Navy (Ret.) Superintendent.

capabilities; and, as a result, had decided that he should become a mathematical astronomer. His entire afterlife bears striking evidence as to how perfectly he had estimated his own capabilities. That conclusion arrived at, no obstacle or inducement ever made him waver from his set purpose.

His father was a country school teacher, who had met many disappointments in life, and at no time was he able to give his son the kind of education he longed for. Thus, left to his own resources, he planned a way. At the age of eighteen, having discovered that the doctor to whom he was apprenticed was only a quack, he ran away and came to the United States. The next year he sought and received employment as a school teacher in Maryland, as near to Washington as possible, so that he could visit the Government libraries and scientific bureaus during week-ends and holidays. In this way he was able to make personal contacts with some of the most eminent scientists in the employment of the Government. They were at once impressed by his fine bearing, marked ability, and intense earnestness.

Armed with letters from Professor Henry, Secretary of the Smithsonian Institution, and Mr. Hilgard, Director of the Coast and Geodetic Survey, he proceeded to the Nautical Almanac Office, then stationed at Cambridge, Massachusetts, where, in January, 1857, he was appointed, on probation, an astronomical computer at a salary of $30.00 per month. Thus, at the age of twenty-two, he had succeeded in reaching the first rung of a ladder that ultimately led him to fame. This ladder he continued to mount until he had become the greatest astronomer of his day, and one of the greatest of all time. In his "Reminiscences of an Astronomer," he refers to this event as "passing from a world of cold and darkness to a world of sweetness and light," and that his "position in the intellectual world was then assured."

In 1857, Hansen's Tables of the Moon were published under the auspices of the British Government. They were based on a few of the many good observations made at Greenwich between 1750 and 1850. Newcomb knew, as well as everyone else in the Almanac Office, that they should have been based on all the good observations made at Greenwich and at all other observatories. (It was not Hansen's fault, as he did the work by contract, and he could afford but one assistant, when he should have had five or six.)

In 1861 Newcomb was appointed a Professor of Mathematics in the U. S. Navy, and assigned to the Naval Observatory for duty. This gave him an opportunity to test the accuracy of Hansen's Tables by comparing their results with observations of the Moon made by himself. He lost no time in beginning this work, as he states that you can date his assignment to the Naval Observatory by the date of his first observation of the moon. For about two years the moon fell behind its predicted place, with a decreasing rate; and then, for the following years, it forged ahead with an increasing rate.

After disclosing these facts, he was relieved in 1869 from observational astronomy in order that he might devote his entire time to a study of the motion of the moon.

From a few observations of occultations made around 1670, which he had found in the reports, he also found that Hansen's Tables failed to predict the position of the moon before 1750, with the accuracy expected of them. He immediately began a search for more occultations observed before 1750. In 1870 there were two expeditions sent from this country to Spain to observe the eclipse of December 21, 1870. Professor Newcomb alone constituted one of these expeditions. I am not so sure that he ever reached Spain, but there is abundant evidence that he reached the Paris Observatory. Here he spent several months searching the archives for records of observed occultations before returning. He states in his "Reminiscences of an Astronomer" that this was the greatest find of his life. He was three years reducing these observations and several more discussing them; but, when he had finished, the world had a better record of the path of the moon from 1670 to 1750 than could be obtained from Hansen's Tables from 1750 to 1850.

On September 15, 1877, Newcomb returned to the Nautical Almanac Office as Superintendent, this office having in the meantime been removed from Cambridge to Washington. He remarks on this event, "The change was one of the happiest of my life."

At the beginning of the nineteenth century, Laplace, aided by a number of brilliant astronomers, derived approximate values of the astronomical constants and elements of the orbits of all the bodies of the solar system, that were considered sufficiently accurate for the astronomers of that period. This made him the most outstanding astronomer of his time.

About the middle of the nineteenth century, Le Verrier, in working on celestial problems, found that the approximate values of these quantities derived by Laplace were not sufficiently accurate for his requirements. As a consequence, he undertook to redetermine them. This was a tremendous job, that would require many years to finish, but when this long tedious job was successfully finished, he became one of the most distinguished astronomers of all time. In carrying on this work he became so expert in determining the gravitational effects of one planet on another that he detected the existence of the planet Neptune and had determined its position before it had ever been seen.

Owing to the improvements in telescopes towards the end of the nineteenth century, observational astronomy had far surpassed in accuracy the theories for predicting the positions of the heavenly bodies. Again there was a growing demand for better values of the astronomical constants; also, for better values of the elements of all the orbits of the solar system.

Newcomb, from his twenty years spent in practical and theoretical astronomy (especially those years spent on the theory of the motion of

the moon, the most baffling of all celestial problems), was eminently fitted to undertake this job; and he lost no time before beginning it.

Owing to the great degree of accuracy sought, it necessitated the use of all the reliable observations of the sun, moon, and planets (made at all places and at all times), which ran into many thousands. This made it by far the greatest problem ever undertaken by any astronomer. But twenty years later, when this work was drawing to a close and it was found that Newcomb's results were improvements on those of Le Verrier, he became the most distinguished astronomer of his time.

Let us note that in doing this he had transferred the leadership in mathematical astronomy from the banks of the Seine, where it had been for centuries, to the banks of the Potomac, thus adding greatly to the intellectual prestige of our country. It is only fitting that a man with such an achievement to his credit should find a place in the Hall of Fame.

I well remember my first meeting with Professor Newcomb, over forty years ago. I had been offered a position in the Almanac Office, and had come to Washington to report for duty. The Office I found located in two places; all of the force, except Professor Newcomb, were at Nineteenth and Pennsylvania Avenue, while he was two blocks away, at Room 566 of the State, War and Navy Building. I was informed that he never definitely accepted anyone without a personal interview, and that he was too busy to see me then. I was told to call later that evening at his residence.

In the twilight of that evening, as I went up the broad stone steps of his home, my attention was arrested by the rapid approach of a cart and pony. It drew up to the curb, the driver stepped out, and literally anchored the cart and pony, by dropping a large stone with a strap around it. Passing me on the steps, he opened the door and invited me in. I was struck immediately by the leonine appearance of the man. This word "leonine" I owe to James Bryce, when he was Ambassador of Great Britain to this country, who remarked to me in conversation that he once went to Oxford, a distance of ten miles, with no other purpose than just to take a look at Newcomb. He said that he was so "leonine"; also that he was the most striking personality he had ever met.

In the conversation with Professor Newcomb that night I was struck by the fact that I was asked not a question as to my education, experience as a computer, or really anything about my past experience at all. Years later, after becoming Director of the Nautical Almanac, I found from the files that at that time he knew all about me, so the object of the interview was just to look me over.

After working at the Main Office about two months, I was told to report at his room in the Navy Building. I knew I was at the right place when I saw the cart and pony anchored outside. This cart and pony arrangement, and having a room removed from the others, were

only devices to save time; and time was a great item to a man so overwhelmed with work as he was. I found a desk awaiting me. It faced his, but the high top of his desk, augmented by piles of books and manuscripts, cut off the view. There were revolving cases on both sides and at his back. From this point of vantage I saw for nearly two years how this remarkable man worked.

He was always hungry for results, and would not let anything deprive him of them. This disease must have been contagious, for everybody in the Office had it. Here was a corps, not of computers, but of mathematicians of ability, most of whom could have filled professorships in our leading universities with credit; all were striving to push the work along. When one was given a piece of work to do there were few, if any, instructions. One just went ahead and did it. This ability to surround himself with able assistants, and to keep up their interest in the work, was an asset of value, as it relieved him of many troublesome details, and reserved his intellect for the most difficult tasks.

Twice a week he lectured on mathematics at Johns Hopkins University. Those days he did not go to the dining room for lunch, but had John Hart, his messenger, bring it to his desk so that he could go direct to the train. One day Hart tripped on a rug, the lunch going in many directions; some of it on my arm, most of it around Newcomb's feet. Newcomb continued without missing a figure; his only remark being, "Hart, how could I live without you?"

I marvelled at his ability to carry on several pieces of work at the same time; of equal difficulty, but entirely different in nature. How he would concentrate on a piece of work with an intensity that made him oblivious to everything around him; then he would change to another without any confusion or loss of intensity! His brain seemed to be composed of several compartments, that automatically closed and opened as he passed from one subject to another. No energy was lost; all was used for results. It was this characteristic more than any other that made it possible for him to accomplish so much in one lifetime.

THE PLANET MARS

O, planet Mars, of ruddy hue
How often have I gazed at you!
And as you gleam from out the skies
I watch you still with wondering eyes.

I wonder why you are so red;
I wonder if your seas are dead;
I wonder, too, as I look at you,
About your people, what they do.

I wonder if they sow and reap,
If they laugh and sing and weep,
If they have storms of sleet and snow
As we have on the Earth below.

I wonder how those great canals
Have figured in your people's annals.
Though you differ from the Earth,
The same great power gave you birth.

S. M. Melton.

Dedication of the Morrison Astronomical Observatory

By ROBERT R. FLEET

The dedication service for the new Morrison Astronomical Observatory at Central College, Fayette, Missouri, was held on Monday, June 1. The exercises for the day opened with a review of the history of the old observatory and an illustrated lecture by Dr. Harlow Shapley, director of the Harvard College Observatory. Dr. Shapley gave a highly interesting outline of the present status of astronomical knowledge, using as the title of his lecture, "Exploring Outer Darkness." This service at 10:45 o'clock in the morning was open to the public and the large audience included many astronomers and teachers of mathematics and physics from neighboring colleges and universities.

A community picnic lunch was served at noon on the campus of Central College. At 2:00 o'clock a group of especially invited guests, including the visiting astronomers and teachers, met at the new observatory which is located at the edge of the city, not far from the College. In the lecture room Dr. Shapley, by request, explained in a two-hour round-table dicussion the various phases of astronomical research now being carried on at Harvard and other observatories. The day closed with an inspection, by the visitors and friends of Central College, of the new building and instruments.

Dr. Robert R. Fleet, director of the Morrison Observatory, expressed regret that Mrs. Berenice Morrison-Fuller of St. Louis and Dr. Henry S. Pritchett of New York were unable to attend the dedication. It was through the generous gifts of Mrs. Morrison-Fuller that Professor Carr Waller Pritchett, founder of the Pritchett Collegiate Institute and father of Dr. Henry S. Pritchett, was enabled to build the original Morrison Observatory located then at Glasgow, Missouri, in connection with the institute.

History

In 1875 Professor Carr Waller Pritchett through the gifts of Mrs. Morrison-Fuller was able to carry out his plans for the building of the observatory. Mrs. Morrison-Fuller, then Miss Berenice Morrison, a personal friend of Professor Pritchett interested in the advancement of science, was a resident of Glasgow. A talented woman of vision, Mrs. Morrison-Fuller was more than glad to assist in the plans of Professor Pritchett. Her interest in the observatory still continues and she regretted her inability to be present at the dedication of the new building. Professor Carr Waller Pritchett received most of his training in astronomy at the observatory of Harvard College. There he formed lasting friendships with the Bonds, Asaph Hall, Benjamin Pierce, and other distinguished astronomers.

Plans for the original Morrison Observatory were drawn by Albert Stevens, architect, of Cambridge, Massachusetts. They were inspected and approved by Professor Joseph Winlock, then director of the Harvard Observatory. The building had a frontage of 65 feet. The computation and transit rooms were constructed of wood. The equatorial room was in the second story of a brick structure, 24 feet square. So well was this construction done that after sixty years not a crack could be found in these rather massive walls of soft home-made brick.

The pier of the equatorial telescope rested upon a base of hydraulic cement 11½ feet square, 4 feet thick, sunk 10 feet below the surface of the ground. Upon this base was built a tapering pier terminating in a capstone 7 feet above the floor of the second story.

The telescope itself was a 12-inch refractor made by Alvan Clark and Sons. It had a focal length of 17 feet. The tube was of steel. The declination circle was 20 inches in diameter, graduated to 15 minutes of arc, and was read by verniers to 15 seconds. The hour circle was 15 inches in diameter and was graduated to single minutes. It was read by verniers to single seconds. Attached to the telescope was a 3-inch finder with a 50-inch focal length and a clock for motion in right ascension. This equatorial telescope was protected by a hemispherical dome modeled after that of the Harvard College Observatory. It was made of 2x6 inch white pine ribs covered with thin sheeting and heavy tin. The sliding shutters were in four sections, an arrangement calling for an involved system of cranks, wheels, and endless chains. The entire dome, 24 feet in diameter, revolved upon steel balls confined between an upper and a lower iron track. The parts of this dome were made in Massachusetts, shipped to Glasgow, and assembled at the observatory. The equatorial telescope was mounted by George Clark and Alvan Clark, Jr., who came west for that particular purpose. Alvan Clark, Sr., then a very old man, did a great deal of work on this objective.

The Meridian Circle was made by Troughton and Simms of London. Its objective had an aperture of 6 inches and a focal length of 77 inches. It was said to be of the same model as the transit instrument used so long at the Greenwich Observatory with which so much valuable work was done. The 24-inch circles were read by means of eight 21-inch microscopes attached to brass drums. Rings of total reflecting prisms gave a very effective lighting system for the cross-hairs. The dim light of coal oil lamps was intensified by suitable lenses inserted in the axis. Finding circles provided with spirit levels and slow motion were attached near the eye-end of the tube. The micrometer head contained the usual fifteen parallel threads for right ascension reading. Two 4-inch collimators and a mercury basin provided the means of determining the collimation and level constants.

The sidereal clock was made by Charles Frodsham of London. It was a break-circuit clock used in connection with a chronograph constructed by the Clarks. There was also a Negus chronometer with a

condenser and other attachments necessary for its use as a sidereal break-circuit time piece.

The instruments of the transit room were also mounted by George and Alvan Clark, Jr., with the help of W. F. Gardner, instrument maker at the United States Naval Observatory. In addition to these major instruments the Morrison Observatory possessed several important accessories including barometers, thermometers, a filar micrometer for the equatorial, and several smaller telescopes.

The old Morrison Observatory was used almost entirely for research during the lifetime of Professor Carr Waller Pritchett, Sr. Much of the observation was done by his two sons, Carr W. Pritchett, Jr., now an expert mining engineer in Denver, Colorado, and the distinguished Henry S. Pritchett, prominent in the history of the coast and geodetic survey, the Massachusetts Institute of Technology, and the Carnegie Foundation for the Advancement of Teaching.

It was Henry S. Pritchett who first conceived the idea of giving exact time daily to railroads and cities in the west. Time balls were operated both in Kansas City and St. Louis.

The main work with the equatorial telescope was the observation upon double stars, planets, and comets. There is pretty strong evidence that the "Great Red Spot" on Jupiter was first seen and studied by Carr W. Pritchett, Sr., with the 12-inch instrument of the observatory.

After the retirement of Carr Waller Pritchett, Sr., and the passing of his sons into other fields of activity, the Morrison Observatory was directed by Dr. H. R. Morgan now of the United States Naval Observatory. Soon thereafter it entered a period of decline and was finally neglected to the extent that the instruments and other equipment fell into unprofessional hands ultimately resulting in their abuse.

In 1926 steps were taken by Central College to gain possession of the observatory in order to restore its equipment and make use of it in connection with the teaching of astronomy. After this transfer was accomplished, several thousand dollars were spent in restorations and improvements. But Glasgow is fourteen miles from Fayette, so the observatory was an interesting but inconvenient laboratory.

Two years ago Dr. Henry S. Pritchett visited the observatory in Glasgow and became interested in having it moved to Fayette. Through his recommendations the Carnegie Corporation made a liberal gift which was at once increased to $25,000 by the contributions of other friends of the college prominent among whom were Dr. and Mrs. S. P. Cresap of Nebraska City, Nebraska. Dr. Cresap, for many years a curator of the college, and Mrs. Cresap have many times been benefactors of Central College.

The new Morrison Observatory stands upon a high, unobstructed ridge of seven acres within a ten-minute walk of Central College. The building, constructed of brick and concrete, is practically fireproof. The Clark equatorial is mounted upon a reinforced concrete pier that stands

on a solid base 14 inches thick and extending 10 feet below the surface of the ground. The old dome was repaired and used with a more convenient revolving shutter substituted for the old arrangement. The dome is motor-driven. It rests, not on the walls of the room as formerly, but upon a circular concrete beam giving much more space around the walls.

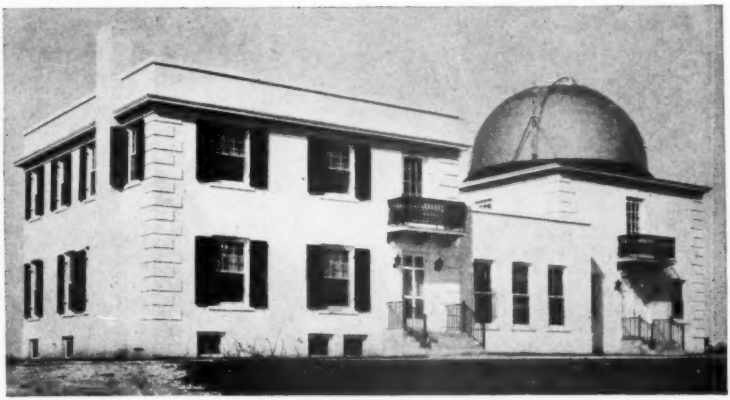

FIGURE 1
NEW MORRISON OBSERVATORY, FAYETTE, MISSOURI
(Photograph by Bullers Studio, Fayette, Mo.)

The clock for the equatorial has not yet been purchased. The motor type is to be preferred if the local alternating current proves steady enough for this purpose. The meridian circle has been remounted together with its former accessories, namely, the collimators, the sidereal clock, and the chronograph.

The transit room is 36 feet long and 16 feet wide. All of the piers are of solid concrete extending into firm clay and isolated from the floor of the room. The room can also be used for smaller transit instruments. Surveyor's transits are available for beginners in practical astronomical studies.

Adjoining the lower floor of the equatorial tower is a lecture room 20x36 feet in size, containing a projection lantern, spectroscopes, barometers, thermometers, a sextant, star maps, celestial globes, photographs of celestial bodies, and various minor illustrative materials. The library is also in this room. It contains a large number of books and pamphlets on astronomical subjects and quite a collection of older star catalogues.

Over this lecture room and a few steps from the equatorial room is an observation deck where students may conveniently observe and sketch the constellations. Shaded lights for sketching are provided

along the coping of the 3-foot parapet.

Directly south of the lecture room and deck is the home of the director. The basement of this dwelling contains a small workshop and a potential dark room. The equatorial and transit rooms are well protected from the heat of the residence and the lecture room.

FIGURE 2

TWELVE-INCH REFRACTING TELESCOPE OF THE MORRISON OBSERVATORY

(Photograph by Bullers Studio, Fayette, Mo.)

The main purpose of this observatory is the teaching of astronomy, but it is hoped that a moderate amount of research may be undertaken as interest develops and the equipment is perfected. Its approximate position is longitude $6^h\ 10^m\ 48^s.00$ W, latitude 39° 9′ 00″.00 N.

The Lunar Appulse of 1936 December 28

By ALEXANDER POGO

On Sunday evening, December 27, 1936, between 9:00 and 11:00 P.M., Central Standard Time, the darkening of the northern part of the moon by the inner layers of the penumbral cone will be observable in America, clouds permitting; the moon will be in the zenith over the North Atlantic, and the lunar appulse will be generally visible in Europe, in the morning hours of Monday, December 28. Opposition in longitude will occur at $4^h\ 0^m$ U.T., and the middle of the eclipse about ten minutes

TABLE I

CIRCUMSTANCES OF THE LUNAR APPULSE OF 1936 DECEMBER 28.

Moon enters penumbra	December $28^d\ 1^h\ 49^m$ U.T.
Closest approach	$3\ 49$
Moon leaves penumbra	$5\ 49$
Magnitude of the eclipse = —0.15 (Moon's diameter = 1.0)	

earlier. The circumstances of the lunar appulse are summarized in Table I and are illustrated by the diagram reproduced in Figure 1; they were derived, by a semi-graphic method, from the ephemerides of the

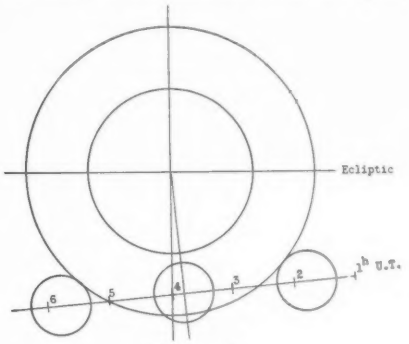

FIGURE 1

THE LUNAR APPULSE OF 1936 DECEMBER 28.

sun and of the moon found in the current nautical almanacs; the precision is sufficient for all practical purposes; the semidiameters of the physical umbra and penumbra were obtained by adding two per cent to the semidiameters of the geometrical umbra and penumbra; the magnitude of the appulse represents the closest approach of the limb to the physical umbra, the diameter of the moon being the unit.

The moments when the moon enters and leaves the penumbra are, of course, unobservable. I shall be grateful for information concerning the time of the beginning and of the end of the visibility—*to the un-*

aided eye—of the darkening of the limb; it is desirable to distinguish between "suspected darkening" and "unmistakable darkening." Observers should not be surprised to find that the theoretical moment of closest approach, $9^h\ 49^m$ P.M., C.S.T., divides the observed duration of darkening into two unequal parts. A discussion of the results of these observations, and of the visibility of penumbral lunar eclipses, in general, will be given in a forthcoming paper.

A synopsis of the essential data concerning the initial penumbral eclipses of the lunar saros series L25 will be found in Table II; they

TABLE II

INITIAL PENUMBRAL ECLIPSES OF THE LUNAR SAROS SERIES L25

	Date	GCT	J.D. GMT	Magn.	λ_s	ϕ_s	P	L	γ
1 a	1702 Aug 7	$19^h\ 19^m$	2342 921.30	—1.00	+ 72	—17	197°.4	314°.6	—1.56
2 a	1720 Aug 18	2 32	49 506.61	—0.89	— 37	—13	196.7	325.2	—1.50
3 a	1738 Aug 29	9 52	56 091.91	—0.74	—148	—10	195.9	335.7	—1.42
4 a	1756 Sep 8	17 22	62 677.22	—0.65	+ 99	— 5	195.3	346.3	—1.37
5 a	1774 Sep 20	0 56	69 262.54	—0.52	— 16	— 1	194.6	357.0	—1.30
6 a	1792 Sep 30	8 42	75 847.86	—0.45	—133	+ 3	194.2	7.8	—1.26
7 a	1810 Oct 12	16 37	82 433.19	—0.37	+107	+ 8	193.7	18.6	—1.21
8 a	1828 Oct 23	0 41	89 018.53	—0.30	— 14	+12	193.4	29.5	—1.18
9 a	1846 Nov 3	8 56	95 603.87	—0.28	—138	+15	193.2	40.6	—1.17
10 a	1864 Nov 13	17 15	2402 189.22	—0.25	+ 97	+18	193.1	51.6	—1.15
11 a	1882 Nov 25	1 44	08 774.57	—0.20	— 29	+21	192.8	62.8	—1.13
12 a	1900 Dec 6	10 23	15 359.93	—0.16	—158	+22	192.6	73.9	—1.10
13 a	1918 Dec 17	19 4	21 945.29	—0.14	+ 73	+23	192.5	85.0	—1.09
14 a	1936 Dec 28	3 44	28 530.66	—0.13	— 56	+23	192.5	96.2	—1.09
15 a	1955 Jan 8	12 30	35 116.02	—0.12	+174	+22	192.5	107.4	—1.08
16 a	1973 Jan 18	21 13	41 701.38	—0.11	+ 44	+20	192.5	118.6	—1.08
17 a	1991 Jan 30	5 54	48 286.75	—0.10	— 85	+18	192.5	129.8	—1.08
18 a	2009 Feb 9	14 33	54 872.11	—0.06	+145	+15	192.3	140.9	—1.06
19 a	2027 Feb 20	23 5	61 457.46	—0.04	+ 17	+11	192.2	152.0	—1.04
20 p	2045 Mar 3	7 36	68 042.82	+0.01	—111	+ 7	192.0	163.1	—1.02

were computed with the aid of Neugebauer's[1] tables; for the eclipses of the XXth and XXIst centuries, Schram's[2] tables of cycles were used, along with Neugebauer's tables. It will be noticed that the data of Table II give $3^h\ 44^m$ U.T., instead of $3^h\ 49^m$ U.T., as the time of the middle of the appulse of 1936 December 28, and —0.13 instead of —0.15 as its magnitude; the agreement is quite satisfactory, if one takes into consideration the nature of Schram's ecliptic tables, on the one hand, and of the semi-graphic method adopted in deriving the data of Table I, on the other. Similarly, in the case of the first umbral eclipse of the series, 2045 March 3, the data of Table II are in good agreement with the data of Oppolzer's *Canon*.[3]

[1] P. V. Neugebauer. *Astronomische Chronologie*, 2 vols. Berlin 1929.

[2] R. Schram. *Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse*. Denkschriften d. Akademie, math.-naturw. Cl., 51, Wien 1886.

[3] Denkschriften d. Akademie, math.-naturw. Cl., 52, Wien 1887. Oppolzer's lunar *Canon* is based on his simplified *Tafeln zur Berechnung der Mondesfinsternisse* (Denkschr. d. Akad., 47, Wien 1883).

The overlapping of the appulses of the lunar saros series L24—the "Columbus series" discussed in a previous paper[4]—and of the appulses of the lunar saros series L25 is illustrated by the diagram reproduced in Figure 2; the relative sizes of the circles representing the moon, the umbra, and the penumbra, correspond to average values—the scale of

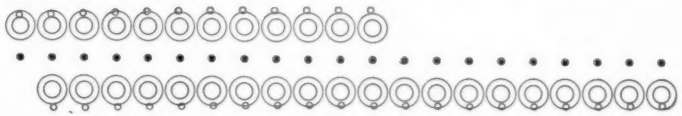

FIGURE 2

TRANSITION FROM SERIES L24 TO SERIES L25.

Upper row: the 11 terminal penumbral lunar eclipses of series L24, preceded by the last partial eclipse of the series, 1684 June 27.
Middle row: central eclipses of the solar saros series S25.
Lower row: the 19 initial penumbral lunar eclipses of series L25, followed by the first partial eclipse of the series, 2045 March 3.

the diagram does not permit us to show the gradual changes of the diameters. The last partial eclipse, 1684 June 27, of the lunar saros series L24 is represented at the left end of the upper row; the first partial eclipse, 2045 March 3, of the lunar series L25 is represented at the right end of the lower row; the 11 eclipses of the terminal penumbral run of series L24 and the 19 eclipses of the initial penumbral run of series L25 form a gradual transition from the end of the umbral run of series L24 to the beginning of the umbral run of series L25. The dots of the middle row of the diagram of Figure 2 represent the new moons which cause the central eclipses of the solar saros series S25. The vertical intervals, in the diagram, between the eclipses of the two lunar saros series correspond to one lunation; the following tabulation may serve as an example:

L24 . . . 1792 Aug 31 . . . penumbral lunar ecl., at the descend. node
S25 . . . 1792 Sep 16 . . . annular solar ecl., at the ascend. node
L25 . . . 1792 Sep 30 . . . penumbral lunar ecl., at the descend. node

The horizontal intervals in the diagram of Figure 2 correspond, of course, to 6585.3 days.

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[4] POPULAR ASTRONOMY, Vol. XLIV, pp. 353-363, Aug.-Sept., 1936.

Sir Norman Lockyer

By V. S. SWAMINATHAN

The centenary of the birth of Sir Norman Lockyer forms a fitting occasion to review the fundamental research work he conducted in the field of astrophysics and assess the important part he played in the promotion of higher and scientific education in this country.

Sir Norman Lockyer was born at Rugby on May 17, 1836, and educated in Europe attending a course of lectures at Sorbonne. He was appointed a clerk in the War Office in 1857 and made a name for himself by editing the Army Regulations. He devoted his leisure time to the study of astronomy, and the work he began as a pastime became in the end the main business of his life. His scientific acumen and proved business ability procured for him the place of Secretary to the Duke of Devonshire's Royal Commission on Science in 1870. Disraeli, who had the knack of discovering and encouraging talent, transferred him to the Science and Art Department at South Kensington. On the foundation of the Royal College of Science, he was appointed Director of the Solar Physics Observatory and Professor of Astronomical Physics.

Sir Norman Lockyer was a pioneer in the application of spectroscope to stellar studies, playing a prominent part in the "process of taking the sun to bits." He did the bulk of his work in London. He carried out his fundamental and far-reaching researches in his private observatory at Hampstead before 1873. He continued his investigations at South Kensington until 1913, the year when the Solar Physics Observatory was shifted from thence to Cambridge. Later with Lady Lockyer's cooperation he built an observatory at Salcome Regis, Sidmouth—today one of the best equipped for the purpose—and carried on there his spectroscopic studies and photographic work to the end of his days.

Sir Norman started the spectroscopic study of sunspots in 1866. Two years hence, Lockyer in London, independently of Janssen in France, discovered a spectroscopic method whereby solar prominences could be observed on an uneclipsed sun—to commemorate which a medal bearing the names of both astronomers was struck by the French Government in 1872. He detected, with Frankland, helium in the sun's spectrum, the gas which was twenty-seven years later isolated by Sir William Ramsay from the mineral cleveite and which is now to be had from the gas wells of Alberta, in amounts sufficient to fill air-ships. From 1872 onwards he began investigating the chemistry of the sun. He also conducted eight British Government expeditions, between 1870 and 1895, accounts of which are given in his "Recent and Coming Eclipses." The significant fact is he was able to cover so much crucial ground with only a single serviceable eye.

It is a tribute to the many-sidedness of his mind and the clarity with

which he noticed the interdependence of sciences, that his researches contributed to advances in Archaeology, Chemistry, and Physics.

While in Egypt, he made an attempt to date certain temples from their orientations, which were so built as to observe the rising and setting of the sun and other heavenly bodies at different times of the year and he extended this knowledge to the study of stone circles in England. His conclusions as regards the date of stonehenge were closely verified by the evidence subsequently derived from excavations on the spot. He was never tired of impressing upon physicists and chemists the importance of sun and stars as a means of investigating the behaviour of matter at high temperatures and as possibly throwing light on the nature of atoms and molecules.

His work was always of a stimulating character, even though some of his conclusions and hypotheses have to be modified in the light of more recent researches—a position shared in common by pioneers. One need only cite as illustrations the Meteoritic Hypothesis, the subject of dissociation, and the suggestive, though by no means conclusive, relationship obtaining between sunspots and terrestrial weather.

It is difficult to exaggerate the part played by Lockyer in popularizing science. With the well-known publisher Alexander Macmillan, he founded "Nature" in 1869 and continued its editor till his death. "The exacting care with which it has been edited, the impartiality and precision of its judgments, the wide range of its information, the accuracy of its reports, have given Nature in its own sphere unique distinction and authority." The mantle of editorship has since fallen on the worthy shoulders of Sir Richard Gregory. Lockyer and Macmillan again cooperated, this time in launching a series of elementary science textbooks, which were a phenomenal success, volumes covering Astronomy, Chemistry, Geology, and Physiology carrying such well-known names as Lockyer, Roscoe, Geike, and Huxley. The British Science Guild, founded in 1905, is a monument to his prescience. His passionate plea for the vigorous prosecution of higher and scientific education as President of the British Association for the Advancement of Science in 1903 did not fall on deaf ears. Within a short time Balfour doubled the grant allotted to university education.

Sir Norman Lockyer contributed in all more than 200 papers to the Royal and Royal Astronomical Societies and was author of "Chemistry of the Sun," "The Dawn of Astronomy," "The Sun's Place in Nature," "Inorganic Evolution," and "Stonehenge and other British Stone Monuments Astronomically Considered." Honors came to him unsought. He was elected F.R.S. in 1869, received the Rumford Medal in 1874, was Vice-President of the Royal Society in 1892-93 and President of the British Association in 1903.

Sir Norman had wider interests in life. He was a close friend of the poet Tennyson and a keen golfer. His revision of the rules published in 1896 had much to do with the form of the rules subsequently adopted

by St. Andrews. His pioneering researches in the realm of astrophysics, and the observatory on the hill-top at Salcome Regis, Sidmouth, stand as imperishable monuments.

BEDFORD PARK, LONDON, ENGLAND, MAY, 1936.

Astronomy with Field Glasses

By O. M. ERPENSTEIN

He who has acquainted himself with some of the wonders of the heavens naturally thinks that large and expensive optical equipment is necessary. It is true that for the majority of celestial objects large and ponderous telescopes, magnifying several hundred times, are needed. This is particularly the case when observing minute planetary detail, separating a close double star, or studying distant nebulae and clusters.

However, the least optical power will reveal objects that the naked eye could not possibly reach. With an ordinary binocular of from three to eight magnifications many objects of the heavens are seen to be of surpassing beauty. With a draw-tube telescope, an instrument which may be obtained having magnifying power from ten to forty diameters, the observer can spend many hours of enjoyment in the study of the heavens. Many stars invisible to the naked eye are seen, and the naked eye stars shine with increased brilliance and more vivid colors.

The field glass or, as it is popularly known, the draw-tube telescope, consists of the usual objective and a terrestrial eyepiece. This latter is generally composed of four lenses in order that the image may be erect. In most patterns this eyepiece is made in two sections, the one nearest the eye being removable. By pulling it out and increasing the distance between the two sections with the help of some cardboard tubing, greater magnification may be obtained. Removing the inside lens of the combination farther from the eye will also increase the magnifying power. This procedure produces a certain amount of distortion, so that only the central part of the field is available, but is worth trying as an experiment. The astronomical telescope has an inverting eyepiece, consisting of only two and sometimes but one lens. The image is therefore upside down, which is of no disadvantage in astronomical observations. There is the advantage of fewer lenses absorbing light, a factor which is of considerable importance when observing faint objects.

The definition of the usual binocular and field glass is not as perfect as that of an astronomical telescope, because in viewing terrestrial objects needle-sharp definition is not absolutely necessary.

Perhaps the most interesting object to observe with a small telescope is the sun, although great care must be exercised lest injury be done to the eyes. Most field glasses are provided with a sun-shade, but opera glasses are not. It is of course a simple matter to improvise one with a piece of smoked glass. The first thing that attracts our attention when

we observe the sun is the diminution of brightness from the center to the edge. Of course this is also evident when the sun is viewed with the naked eye through a smoked glass. The impression is at once conveyed that here is a sphere and not a disc. Sunspots, whenever present, are easily seen with a magnification as low as ten. As the number and size of sunspots vary through a cycle of about eleven years, there are times when some very large ones can be seen even with the weakest opera glass. Many instances are on record of spots large enough to be seen with the naked eye.

A very effective and much less tiring way of observing the sun is to first provide the telescope with a mounting. Then fix a stout wire arrangement to the eye-end of the telescope to receive a piece of white paper. Also have a square piece of cardboard, with a central hole cut so that it will fit over the objective end of the telescope. This is needed to keep the direct rays of the sun from the paper. The image of the sun may now be projected onto the paper and any spots present will be seen. The farther the paper is from the eyepiece, the larger, and incidentally the fainter, will the image of the sun be. The practical limit is easily found by trial. With one of the smaller field glasses, magnifying perhaps ten times, the image of the sun will be about one and a half inches in diameter. With one of the larger glasses, having an object glass of perhaps two inches, and magnifying 40 times, the sun's image may be three inches or more. It must not be supposed that *all* spots on the sun's surface can thus be seen, even by direct observation with our instruments. Many of the spots are so small as to require large telescopes and high magnifications to become visible. Also, viewing the sun's image on paper will not show the detail that can be seen by direct observation. It is a method that is very convenient, and is often used by astronomers when the object is to secure the relative position of spots.

With many field glasses of larger size, or if only a very moderate sized image suffices, this projection of the image on paper can also be done in the case of the moon. Especially at the time of full moon can a bright image be secured. Then, however, very little detail is seen on the moon even by direct vision, because the light is "head-on" and there are no shadows to show the irregularities of its surface. The method is particularly interesting during an eclipse, chiefly because several persons can watch the phenomenon. In any case, it will be noticed how rapidly the image of the sun or moon traverses the field of view, and frequent adjustment is necessary. This motion is, of course, due to the rotation of the earth, and is taken care of in observatories by mounting the large telescopes in such a manner that they can be driven by clockwork at the same angular rate that the earth rotates, so that the object always remains in the field of view.

The moon is more interesting, however, under direct observation. As low a power as two times will show the outlines of many of the craters. With a knowledge of where the craters are located, some can occasion-

ally be made out with the naked eye. This is a principle well to keep in mind: if you have seen some of the celestial objects with superior optical means, it is much easier to see them with small telescopes. The craters are best seen on the line that divides the moon into light and dark, the terminator. With a field glass of only ten-fold magnification the moon is a glorious sight. By seeing the whole disc at once one notices how the craters towards the edges are foreshortened, clearly indicating that the moon, like the sun, is a sphere. In large astronomical telescopes the field of view is generally too small to show the whole moon at once.

With the planets we enter the field where large instruments are definitely superior; and yet, many interesting observations can be made with smaller instruments. Let us begin with Jupiter. Unless the telescope magnifies upwards of ten diameters the disc of the planet is not readily visible. In the larger type of field glasses, magnifying 40 or more times, the disc and its oval shape are easily seen. With a telescope having an object glass a little over two inches in diameter, and magnifying 45 times, the author has at times glimpsed some of the belts seen on illustrations of the planet in books on astronomy. The four largest satellites of Jupiter are easily visible. Almost any optical means will bring them out, indeed a few instances are on record where one or two have been seen with the naked eye. The satellites present an ever varying spectacle. They are always arranged on an almost straight line, like beads on a wire. The innermost revolves about the planet in a little over one day, and the outermost in 16 days. Thus the general aspect changes from night to night. Now and then one of the satellites passes behind the main body of the planet and we cannot see it. The passage of a satellite across the planet's disc and its shadow are phenomena quite beyond small telescopes. These four satellites are not all of Jupiter's "Family." There are nine altogether. The other five are visible only in large instruments.

Next of interest is Saturn, the planet with a ring. The average total width of the ring is about 1/30 of the apparent diameter of the moon, so that with a telescope magnifying 30 times Saturn would appear as large as the moon seen with the naked eye. With a telescope magnifying only ten times, it would appear 1/3 as large as the moon. It does not require, therefore, great optical power to show the rings. Of course, detail is out of the question, and the definition of the telescope and condition of the atmosphere may be such that sharp vision is not obtained. As an example, look at the moon through a small telescope or opera glass while it is very near the horizon. You will notice that the air is constantly in motion. This is an extreme example, but this unsteadiness is present more or less in all parts of the sky.

Saturn has nine satellites, none of which can be seen with small telescopes. Uranus and Neptune are of interest only in following their courses among the stars, once they have been located by reference to a

good map. Their discs are beyond all but fairly large telescopes.

The discs and crescents of Mercury and Venus are best seen in the daytime. Mercury is very difficult to locate thus with our instruments, but Venus is often visible to the naked eye at high noon as an intensely brilliant white point.

The disc of the planet Mars is visible, when favorably situated as at opposition, in the larger sizes of field glasses, sometimes the polar "ice-caps" being discernible. The red color of the planet is very evident. Its two satellites can be seen only with very large telescopes.

To one who has never beheld the heavens through a telescope, the increased number and brilliance of the fixed stars is a sight never to be forgotten. Hours can be spent in enjoying a steady change of stellar vistas. Especially are these interesting in regions near the Milky Way, where the stars are thickly clustered. The nebulae are rather disappointing objects in small telescopes. They are at best visible as luminous patches. The famous whirlpool nebula, so often mentioned and pictured, is satisfactorily visible only in the very largest telescopes, and many of its details are accessible only to the photographic plate.

The clusters of stars are also mere luminous patches, a few isolated instances being exceptions. Particularly in the constellation Scorpio, near the Milky Way, are some clusters that can be partially resolved. The Beehive in Cancer, Coma Berenices, and the Pleiades are beautiful sights in small telescopes. The resolution of the Milky Way into its many stars is possible only with large instruments.

Some of the wider double stars can be separated with a small telescope. The "rider" in Ursa Major is an example. Also the star at the foot of the cross-like figure in the constellation Cygnus can be separated with some instruments. In general, double stars are few that can be seen with field glasses and opera glasses. They may serve as an occasional test of the optical qualities of such instruments.

The writer of this article has assumed that the reader is somewhat familiar with matters astronomical. He may not possess a telescope of sufficient size to enable him to see the wonders of the universe as pictured in books on astronomy, but he can nevertheless derive great pleasure from the contemplation of the heavens with very small instruments. Galileo's Telescope magnified only 32 times, and its definition was inferior to even the cheapest field glass today.

The Astronomer Talks

By RUFUS O. SUTER, Jr.

We had regarded the astronomer a man of no practical use to this world. He lives in the heavens, we thought, and spends his days meditating on infinity, measuring stars, and arguing on the Nebular Hypothesis. The poet, even, we had considered of greater practical use. While he inspires and entertains the world with his verses, the astronomer, if he does discover something interesting, hides his work in abstruse mathematics and technical terms. We admitted the astronomer has a giant intellect. We could not help admiring him, and looking with awe on his gigantic telescopes; but we could not connect him and his observatory with the rest of the world.

The other day we had the opportunity of talking with a professional star-gazer. How suddenly our opinions changed! The astronomer came down from the lofty place we had created for him, and we saw him as he is: a man, like other men, working for the good of humanity. The astronomer we now consider indispensable. We realize it is he who tells us when to eat breakfast; when the train leaves; when to catch the street-car; when to reach the baseball field to see the first inning. We realize that we regulate every action of our lives according to his calculations.

Astronomy, declares the astronomer, is so closely connected with the affairs of everyday life that we overlook its importance. Are not our divisions of time: the year, month, day, hour, minute, and second, astronomical observations? From time immemorial men have gaged and dated their actions with regard to the motions of the heavenly bodies. They have bound the past to the present, and we are binding the present to the future. In these days of hustle and bustle accurate time is an absolute necessity. Every business, every pleasure, every action from the smallest personal affair to the greatest world affair is regulated to the calculations of time. Who makes these calculations? The astronomer. He is the systematizer of the world. We eat, sleep, work, play, go, come—each movement of our lives is done according to his calculations. Imagine the results if for one month we should lose every method of telling time. Trains would stop running; ships would cease sailing; business would stop; everything would stop. Each person would lose his connection with the rest of the world. Chaos would reign supreme.

If this were the only use of astronomy its pursuit would be justified; but the enthusiastic star-gazer says he has only begun to discuss the benefits of his profession. Navigation would be an impossibility, he continues, were it not for the astronomer. Did you ever consider what a gigantic task it is for the mariner to bring his ship safely to port? For days he guides his tiny craft across shoreless seas; nothing below

him but fathoms of water; nothing above him but infinite space; and he lands the good ship at a given point on the surface of a vast world. It seems miraculous. How is it done? Entirely through a knowledge of astronomy—a knowledge of the positions of the heavenly bodies.

The world has been mapped through astronomy. Boundaries of nations are determined by the astronomer's accuracy. The foundation of surveying is a knowledge of the geometric properties of the celestial sphere. Man would be a sad creature if he did not know the size and shape of the continent on which he lives, and of the world which is his home.

Astronomy has brought mankind from the depth of ignorant barbarity and superstition to a comparatively high state of civilization. Men's minds are broadened with the advance of knowledge concerning the universe. In early days when astronomy, shrouded with superstition, taught that earth is the sacred foot-stool of the Almighty; that the heavens are glass spheres; that the sun, moon, and stars are little lights placed in the sky for our pleasure—man was a pitiable, narrow-minded creature. He lived in constant dread of fairies, phantoms, devils, gods, omens, and numberless other creations of his fancy. His mind was directed toward the animal passions. Food, drink, and conquest offered his only subjects of thought. Kings held the sway of gods over men; torture was the only means of correction . . . Gradually astronomers laid aside their primitive teachings, despite persecution by the world which considered it sacreligious that ancestral beliefs should be destroyed. Earth lost its false importance and became an infinitesimal speck in an infinite universe. Stars changed from tiny lights to vast worlds and suns. Man's mind, following the progress of astronomy, broadened. Superstition vanished. Fairies and devils ceased to exist. Omens lost their significance. The power of kings declined. The world became a fitter place for life.

Though the world today is better than it was yesterday, it has by no means reached perfection. Where the light of the science of the universe has not yet penetrated, superstition still holds its own. From time to time Neros arise and wars rage, but through it all, progress is certain. "It is astronomy," said Sir Edward Arnold, "which will eventually be the chief educator and emancipator of the human race." Wars and strife will cease to exist when man entirely forgets his insignificant importance and meditates more on the vast creation around him. Slowly but surely astronomy is bringing him to this point.

WARREN, PENNSYLVANIA.

Planet Notes for December, 1936

By CLIFFORD E. SMITH

Note: All times, unless otherwise stated, are Central Standard Time.

The *Sun* will be moving with an apparent southeasterly motion until the time of the winter solstice on December 21 at 6:00 P.M. After that time its apparent motion will be northeasterly. On December 13 there will be an annular eclipse of the sun which will be visible in Australia. The motion of the sun among the constellations will be from western Ophiuchus to the central part of Sagittarius. At the beginning of the month the distance from the earth to the sun will be about 91.6 million miles, and this distance will decrease about a quarter of a million miles during the period. The position of the sun on the first and last days of the month will be as follows: R.A. $16^h\ 28^m$, Decl. $-21°\ 45'$ and R.A. $18^h\ 40^m$, Decl. $-23°\ 8'$.

The phenomena of the *Moon* will occur as follows:

Last Quarter	Dec.	5	at 12	NOON
New Moon		13	" 5	P.M.
First Quarter		21	" 5	A.M.
Full Moon		27	" 10	P.M.
Apogee		9	" 2	P.M.
Perigee		25	" 3	P.M.

Mercury will be moving with an apparent easterly motion from the southern part of Ophiuchus to the eastern part of Sagittarius. During the first part of the month it will be near the sun in apparent position, but by the end of the month it will set about an hour and a half after the sun. Conjunction with the moon will occur on December 17. At the end of the month the distance from Mercury to the earth will be about 90 million miles and the apparent diameter of Mercury will be about 7 seconds of arc. Greatest elongation east (19° 37′) will occur on December 29. The position of Mercury on December 31 will be R.A. $20^h\ 4^m$, Decl. $-21°\ 24'$.

Venus will be an early evening object, and, during the month, it will move from central Sagittarius, across Capricornus, to western Aquarius. It will set about three hours after the sun. The distance from the earth to Venus will decrease from about 108 million miles to about 90 million miles, and the apparent diameter will increase from about 14½ to about 17½ seconds of arc. Conjunction with the moon will occur on December 17 at 11:00 A.M. (Venus 6°.0 S).

Mars will be a morning object in Virgo, and it will rise an hour or so after midnight. At the beginning of the month the distance from the earth to Mars will be about 180 million miles, and this distance will decrease about 25 million miles during the period. Its apparent diameter at the end of the month will be about 5½ seconds of arc. Conjunction with the moon will occur on December 8 at 7:00 A.M. (Mars 6°.9 N).

Jupiter will be near the sun in apparent position. Conjunction with the sun will occur on December 27 at 10:00 A.M.

Saturn will be an evening object in Aquarius, and it will set an hour or so before midnight. Its distance from the earth will be about 900 million miles, and its apparent diameter will be about 15 seconds of arc. Quadrature east of the sun will occur on December 8. Conjunction with the moon will occur on December 20 at 1:00 P.M. (Saturn 8°.0 S).

Uranus will be a night object in Aries. During the middle of the month it will set about 2:30 A.M. for northern observers. The motion of Uranus among the stars will be retrograde. Its distance from the earth will be about 1770 million miles, and its apparent diameter will be about 3.6 seconds of arc. Conjunction with the moon will occur on December 23 at 9:00 P.M. (Uranus 4°.6 S). The position of Uranus on December 15 will be R.A. $2^h\ 15^m$, Decl. +13° 5′.

Neptune will be a morning object in southeastern Leo. It will rise about midnight since quadrature west of the sun will occur on December 10. Its distance from the earth will be about 2800 million miles, and its apparent diameter will be about 2.4 seconds of arc. Conjunction with the moon will occur on December 6 at 4:00 A.M. (Neptune 6°.9 N). Its position on December 15 will be R.A. $11^h\ 21^m$, Decl. +5° 20′.

OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris.*)

Occultations Visible in Longitude +72° 30′, Latitude +42° 30′.

Date 1936		Star	Mag.	Immersion: Greenwich C.T.	Immersion: *a*	Immersion: *b*	Immersion: Angle E from N	Emersion: Greenwich C.T.	Emersion: *a*	Emersion: *b*	Emersion: Angle E from N
				h m	m	m	°	h m	m	m	°
Dec.	1	ξ Gem	3.7	5 7.5	−1.6	+1.0	87	6 22.7	−1.7	−0.8	298
	2	3 Cnc	5.8	4 20.2	−1.0	+1.3	90	5 30.2	−1.4	−0.2	300
	8	370 B.Vir	6.0	9 23.5	−1.1	+0.5	113	10 40.7	−1.2	−0.4	310
	18	c^1 Cap	5.3	22 32.4	−0.7	+1.2	26	23 34.1	−1.5	−1.3	271
	18	c^2 Cap	6.2	23 1.0	−2.0	−1.7	105	23 51.3	−0.1	+1.7	193
	25	τ Ari	5.2	4 46.6	−1.4	+0.7	47	5 41.3	−0.7	−2.4	299
	25	63 Ari	5.2	5 50.9	..	..	172	5 53.4	..	..	176
	25	65 Ari	5.9	6 24.7	+0.3	−4.4	150	6 51.0	−1.4	+2.1	201
	25	192 B.Tau	6.2	22 22.9	−0.6	+1.4	84	23 25.7	−0.8	+1.6	249
	26	υ Tau	4.4	5 14.0	−1.3	−1.2	100	6 22.9	−1.1	−0.9	261
	26	72 Tau	5.4	5 47.4	−1.4	+0.1	61	6 45.1	−0.5	−2.3	302
	27	175 H^1 Tau	6.5	10 8.5	0.0	−1.1	91	10 58.9	+0.4	−1.3	288

Occultations Visible in Longitude +91° 0′, Latitude +40° 0′.

Dec.	1	ξ Gem	3.7	4 41.4	−1.0	+1.3	88	5 51.9	−1.5	+0.3	287
	2	3 Cnc	5.8	4 5.5	−0.3	+1.4	88	5 7.8	−0.9	+0.4	295
	8	370 B.Vir	6.0	9 13.2	−0.2	−0.4	142	10 17.6	−1.1	+1.0	276
	9	83 Vir	5.7	12 0.9	−0.8	−0.6	141	13 18.4	−2.0	+0.3	279
	18	c^1 Cap	5.3	22 21.7	..	..	351	22 54.6	..	..	304
	18	c^2 Cap	6.2	22 23.8	−2.0	+0.2	78	23 38.5	−1.0	+1.0	216
	20	κ Psc	4.9	22 27.8	..	..	119	23 2.5	..	..	172
	25	τ Ari	5.2	4 14.9	−1.8	+0.9	58	5 26.3	−1.6	−1.4	280
	25	192 B.Tau	6.2	22 15.2	+0.1	+1.6	68	23 10.7	−0.4	+1.2	266
	26	υ Tau	4.4	4 46.7	−1.9	−1.4	115	5 56.1	−1.9	+0.6	239
	26	72 Tau	5.4	5 16.5	−1.8	0.0	80	6 31.7	−1.5	−1.2	277
	27	175 H^1 Tau	6.5	10 11.1	−0.1	−1.7	118	11 4.8	−0.2	−1.1	264

Occultations Visible in Longitude +120° 0′, Latitude +36° 0′.

Dec.	1	ξ Gem	3.7	4 24.6	+0.1	+1.5	74	5 19.3	−0.6	+0.4	294
	3	209 B.Cnc	6.5	13 10.8	−1.8	−1.3	115	14 30.7	−1.2	−2.1	309
	6	*e* Leo	5.1	12 24.0	−1.5	−0.6	126	13 50.4	−1.8	−1.1	306
	9	85 Vir	6.2	11 51.3	−1.0	+2.2	75	12 40.8	+0.1	−1.5	341
	20	207 B.Aqr	6.4	0 33.9	−2.5	+0.3	86	1 44.2	−0.9	+2.0	203
	25	τ Ari	5.2	3 21.8	−1.2	+2.4	45	4 31.5	−2.2	−0.1	278
	26	υ Tau	4.4	3 48.6	−2.0	0.0	109	4 55.7	−1.5	+2.2	229
	26	72 Tau	5.4	4 18.7	−1.8	+1.1	80	5 38.1	−2.0	+0.6	260
	26	τ Tau	4.3	11 49.4	−0.2	−1.1	93	12 43.0	+0.2	−1.1	277
	31	*h* Leo	5.3	8 17.7	−1.7	+0.1	111	9 38.4	−1.7	−1.0	307

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b;* apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Comet Notes

By G. VAN BIESBROECK

COMET 1936 *c* (JACKSON). A cablegram sent from the Union Observatory, Johannesburg, South Africa, reported on September 21 the discovery of a comet by C. Jackson. The first information received was as follows:

1936 Sept. 20.8414 $\alpha = 22^h\ 59^m\ 48^s$ $\delta = -12°\ 47'$
Magnitude 12 Daily motion $1^m\ 5^s$ east, 25′ south.
Object diffuse No mention of tail.

It has since been learned through the Union Astronomer H. E. Wood that, like Comet 1935 *b* found by the same discoverer, this one was detected on plates taken September 15 for minor planet observations. The plates were, however, not examined until the night of September 20, when the faint object was photographed again and was also examined visually with the 26-inch telescope.

On account of the faintness and the southern position few observations have been made. Jeffers at the Lick Observatory, and the writer at Yerkes seem to be the only observers who followed it in the northern hemisphere. From Yerkes observations on September 22, 23, and 25 L. E. Cunningham deduced a preliminary elliptic orbit corresponding to a period of 6.8 years. When new positions became available in October, after the full moon, this orbit was revised both by Cunningham at the Harvard Observatory and by Herrick, Kron, and Miss Hill at Berkeley with substantially the same result:

	Berkeley	Harvard
Perihelion passage	1936 Oct. 3.3919	1936 Oct. 3.67
Longitude of node	164° 14′ 26″	164° 13′.7
Inclination	13 16 51	13 15.0
Node to perihelion	197 18 5	197 31.3
Perihelion distance	1.462290	1.4615
Eccentricity	0.649929	0.6500
Period in years	8.5376	8.53
Dates used	Sept. 22, 25, Oct. 7	Sept. 22, 25, Oct. 8

The motion can be seen from the following abstract of the ephemeris:

	α h m s	δ ° ′	—Distance from— earth	sun
Oct. 31	0 0 3	—20 27	0.64	1.49
Nov. 4	7 14	20 13	0.67	1.50
Nov. 8	0 14 30	—19 50	0.70	1.52

The comet was near its maximum brightness at the time of the discovery. Since then it has faded rapidly. I called it 14^M as seen in the 40-inch refractor on October 12, when it was recorded as an extremely diffuse round coma about 30″ in diameter. The geometric conditions indicate further diminution in brightness so

that this object will not be followed very long. A. C. D. Crommelin points out a certain analogy of the orbit with that of Comet 1895 II (Swift) for which H. R. Morgan gave a period of 7.219 years, also the fact that on account of close approaches to Jupiter the elements may have been altered in the course of the five intervening revolutions. It is too early to establish this definitely.

Except for the COMETS 1935 *d* (VAN BIESBROECK) and 1936 *b* (KAHO), which can be reached only through the most powerful telescopes, there are no other known comets observable from northern stations.

Reports about the southern course of the bright comet 1936 *a* (PELTIER) are now becoming available. Many observations are reported in the "Southern Stars" for September. On August 6 and 7 New Zealand observers found the comet to have a fine tail easily visible to the naked eye and estimated its length at four degrees. The magnitude was then about 3^M. This dropped to 5^M by the middle of August and to 7^M towards the end of the month. Numerous measures of position were made at several southern observatories so that there will be abundant material for the determination of the orbit.

The chances of recovery of the expected PERIODIC COMET D'ARREST remain little changed during the balance of the year. The search ephemeris is continued here from page 452:

1936 0^h U.T.	α 1936.0 h m	δ 1936.0 ° ′	r	Δ
Nov. 8	17 4.4	−13 48		
16	17 28.7	15 9	1.494	2.268
24	17 54.1	16 20		
Dec. 2	18 20.7	17 16	1.434	2.253
10	18 48.2	17 57		
18	19 16.4	18 21	1.394	2.250
Dec. 26	19 45.2	−18 27		

It shows that the region is low down in the southwestern sky shortly after sunset.

Williams Bay, Wisconsin, October 20, 1936.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

New Observers: The following observers have contributed initial reports during the month of September: Miss Virginia Covert, of Brooklyn, New York; Miss Mary Hunt, of Taunton, Massachusetts; Rev. J. F. Kempinski, of Island Creek, Massachusetts; Mr. Thomas A. Martin, of Oshkosh, Wisconsin; and Mrs. Hilda M. Whittier, of Reading, Massachusetts.

Observations: Observations were contributed during the month of September by the following observers:

Name	Vars.	Observations	Name	Vars.	Observations
Adamopoulos	3	6	Blunck	37	64
Ahnert	27	176	Brocchi	40	86
Ancarani	14	51	Brockmeyer	5	11
Ballhaussen, Miss	20	46	Brown, S. C.	16	20
Beck	1	1	Buckstaff	16	59

Name	Vars.	Observations	Name	Vars.	Observations
Cameron	13	25	Kohman	10	18
Campbell	2	2	Koons	62	77
Chandra	105	154	La Fon	17	17
Chartier	12	12	Loreta	70	181
Christman	18	18	Luczka	3	6
Cilley	60	152	Marshall	19	54
Covert, Miss	5	5	Martin	15	29
Dalton	8	16	Mennella	12	29
Doolittle	14	20	Millard	37	118
Ellis	67	182	Moore	3	4
Ensor	77	151	Murphy	9	24
Fairbanks	5	5	McLeod	31	112
Focas	75	159	McNeill	9	35
Ford	24	31	Peck	25	149
Franklin	17	30	Peltier	155	336
Gregory	2	2	Recinsky	10	41
Haas, W.	7	48	de Roy	11	66
Hamilton	56	126	Russell, J.	10	41
Hartmann	107	202	Schattle	5	40
Herbig	55	366	Schmidt, R.	3	9
Hiett	24	78	Seely	10	32
Holt	34	42	Segers	2	11
Houghton	74	195	Shinkfield	12	12
Howarth	7	7	Shultz, Miss	11	11
Hunt, Miss	1	1	Sill	29	51
Huruhata	6	30	Smith, F. P.	21	39
Jacobs	1	25	Smith, F. W.	11	15
Jensen	6	8	Strelitzer	22	48
Jones	98	386	Treadwell	8	36
Kasai, K.	3	27	Walton	4	12
Kempinski	1	1	Watson	6	17
King	27	39	Webb	30	38
Kirkpatrick	21	119	Whittier, Mrs.	3	3
Kitchens	3	4	Whittier	4	9
de Kock	35	120	Williamson, D. E.	16	17

Gamma Cassiopeiae: Renewed interest in the suspected variability of Gamma Cassiopeiae has been aroused by the observation of Dr. Cherrington, of Perkins Observatory, when he noted on October 5 that this star was about six-tenths of a magnitude brighter than normal. For many years, minor variations of its peculiar spectrum had been noted. It was the first star ever discovered to have bright lines. Because of the spectral variation, it has long been expected that the star might show evidence of a change in magnitude.

In observing this interesting star, one must use extreme caution. The stars for comparison should be approximately of the same altitude as Gamma and observations should be made only under the best observing conditions. Normally the star is only slightly fainter than Polaris and any marked deviation from this near equality should be carefully noted. If possible, nearby stars in Cassiopeia should be used for comparison purposes.

Mira Ceti: This famous long-period variable star is again due at maximum late in October. It will be the three hundred and seventy-fourth maximum which has occurred since its discovery in 1596, if we assume that the period of eleven months, or 331.6 days, was valid throughout the seventeenth and eighteenth centuries, for, of course, not all maxima have been actually observed, especially in the earlier years. Although the mean maximum magnitude is around 3.0, the star at times rises only to the fourth magnitude, while at other times it has reached the

second. The most recent instances of very bright maxima were in October, 1906, and again in January, 1935. This star is now ideally placed for observation.

R Coronae Borealis Type Variables: All four of the R Coronae type variables regularly on the A.A.V.S.O. observing list, are now at normal maximum brightness: R Coronae Borealis, 6.0; SU Tauri, 10.0; S Apodis, 10.0; and RY Sagittarii, 7.0. SU Tauri was at minimum, fainter than the fourteenth magnitude, in the autumn of 1935. S Apodis was at minimum, fainter than magnitude 13.5, during the latter part of 1934 and the first half of 1935. R Coronae Borealis, after a maximum of ten years duration, passed through a minimum late in 1934 and early in 1935. RY Sagittarii was at minimum, fainter than the thirteenth magnitude, during the winter and spring of 1933 and 1934.

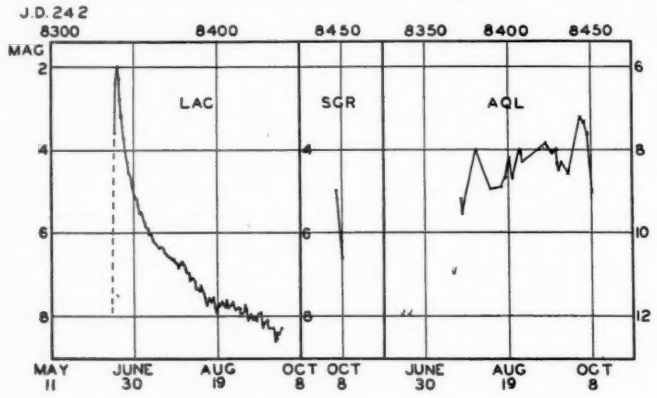
New Variable Stars in Northern Milky Way Window: In the current investigations at the Harvard Observatory on the size of the galactic system and on the distribution of obscuring matter within its bounds, an interesting combination is made of studies of external galaxies and variable stars. In a paper soon to be published Dr. Shapley and Miss Constance Boyd report on the discovery of 27 new variables in a transparent anti-center region of the Milky Way—that is, a region of the Milky Way that is approximately opposite to the direction to the center in Sagittarius. The region studied is in the constellation Auriga. The long-exposure photographs show that external galaxies are very numerous in this region. There are something like forty per square degree on photographs that reach to the eighteenth magnitude. This richness in galaxies must mean that the sky is not seriously affected by obscuring matter; in fact, it must be about as clear as at the galactic poles. It is possible, therefore, to use faint variable stars as indicators of the extent of the Milky Way in the anti-center region and the present list of variables seems to indicate that we have now reached all the way through to the boundary. The plates on which variable stars were investigated reached to the eighteenth magnitude, but very few variables fainter than the fifteenth magnitude were found. Tens of thousands of stars fainter than the fifteenth magnitude were examined, but apparently they are chiefly dwarfs, main sequence stars and not the distant giants which are susceptible of variability. The authors conclude that possibly none of the new faint variables are more distant than ten thousand parsecs. We might conclude from this admittedly preliminary result, therefore, that the Milky Way does not extend away from the center (except possibly for some widely outlying star) farther than 30 or 40 thousand light years. The new variable stars in Auriga include several types: long period, irregular, and cluster-type Cepheids predominating. The shortest period determined is six-tenths of a day, and the longest 365 days.

Novae: Nova Herculis 1934 continues to fade away slowly, the latest observations placing the magnitude at about 7.7.

Nova Lacertae 1936 is also fading slowly in light, now at about magnitude 8.4. There appears to have been a slight halt between August 20 and September 6, and since then the decrease has been more gradual.

Nova Aquilae 1936: Still another nova has appeared to demand the attention of variable star observers. This nova was discovered on September 18, by Nils Tamm, who has a private observatory at Bro, Sweden. It was apparently a photographic discovery and the star rose from a magnitude fainter than 16.0. Its photographic history before discovery, as indicated from Sonneberg and Harvard plates, is quite complete. It was fainter than 11.0, on July 17. On July 20, it attained magnitude 9.7. By August 1, it had reached the eighth magnitude and

then, somewhat suddenly, it decreased to the ninth magnitude, after which it then rose to the eighth. With another decrease to magnitude 8.8, after actual discovery, it increased in brightness until, early in October it attained the magnitude 7.2. By October 8, the Nova had decreased to the ninth magnitude. It is yet too early



LIGHT CURVES OF THREE 1936 NOVAE

to predict what it will do in the future. The star somewhat resembles Nova Pictoris 1925, and may have risen from an exceedingly faint magnitude. A preliminary chart has been issued by the A.A.V.S.O. but without magnitudes assigned to the comparison stars. A photovisual sequence is being determined at Harvard and in the meantime observers are asked to record the brightness of the Nova by Argelander's method, using the nomenclature indicated on the chart. Such charts may be obtained from the A.A.V.S.O. Chart Curator, Mr. Ferdinand Hartmann, 171-25 144th Avenue, Springfield Gardens, L. I., New York.

The Nova has a strong reddish-yellow tinge, enough to identify it readily in the telescopic field. Were it not for the spectral characteristics, one would be inclined to classify the star as, perhaps, a long-period variable, from the light curve, but the available photometric data and the spectral changes preclude such classification. Dr. Harper and Dr. Petrie, of the Dominion Astrophysical Observatory, find, on the strength of calcium H, a probable distance of 700 parsecs, or about twenty-three hundred light years.

Nova Sagittarii 1936: On October 5, word was received from Copenhagen, asking confirmation of a possible fifth magnitude nova near Epsilon Sagittarii, reported as discovered by an observer at Tokyo. Such confirmation was received on October 7, from the Astronomer Royal at the Cape of Good Hope, who reported it as sixth magnitude on October 6 and in R.A. $18^h\,04^m\,30^s$, Decl. $-34°\,21'$ (1936). On October 8, this Nova was observed at Harvard at magnitude 6.8, indicating a somewhat rapid decline in light. The star is unfavorably placed for observations in the northern hemisphere, but ideally situated for southern observers. This makes the sixteenth well-authenticated nova discovered in the constellation of Sagittarius where about one sixth of all the novae in our own galactic system have been found.

October 9, 1936.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

Anyone looking over the data in the table which follows will be struck by the fact that for so many of the periods of observation, the *most important information* is lacking, namely, the hourly rate. Why is this true? At the risk of being considered ungrateful to persons who took time and trouble to observe, I am going to put the facts so bluntly and in such plain language that no one can possibly misunderstand them. Year after year we receive reports from which the rates cannot be computed, and their consequent loss in value is particularly unfortunate as it is no more trouble to do the thing right than wrong. And we are distressed at having so large a part of our tabular matter partly useless.

The point is this: the only unit that has any meaning is the number of meteors seen per hour by *one person*. Cannot that be understood? A count by two or three or more, where they count together, is useless as a comparative figure. If one observer omits from his totals meteors also seen by another because they are "duplicates," this affects his rates so that they are incomplete. Even if the same meteor is seen by a group of a dozen observers, it should be counted by every one. What is seen by the other person is not the individual observer's business: let him do his own counting only, and forget the rest.

Undoubtedly the basis for the tenacity of some groups in ignoring these instructions comes from their wholly erroneous idea that a group of observers sees all the meteors visible from that station, and that "duplicates" should be omitted from the count in order to make it a true record of the number of meteors which actually appeared. This is flatly wrong. H. A. Newton long ago worked out that it would take 32 observers at one place, with regions most carefully indicated, to see all the meteors that appear. As our most ambitious group has never approximated this in size, and as the very large ones have never been thoroughly organized (there are always too many one-night casual helpers to make effective organization possible), of course the group counts that come in entirely fail to accomplish what their organizers desire. Perhaps this explanation will help to eradicate our troubles.

If there are several observers, we do strongly advise that they face in different directions; but when a meteor comes from one man's area into that of another, *both* must count it. Only in this way can the observations be used for rates which may be compared from night to night or from year to year. Failure to report the numbers *individually* is the most common error and the one most grimly adhered to. The instructions in Bulletin No. 15, based upon the experience of many past decades, are perfectly plain on this point, but they are either inadvertently forgotten or, in some cases, deliberately ignored by persons who feel that their way is better. There is no reason why the leader of each group should not carefully explain to his helpers not only what to do, but why it is so necessary for each count to be wholly individual.

The second error is that observers are careless in giving the exact minute when they begin and end observations, contenting themselves by giving the times of the first and last meteors. This vitiates their rates.

The third error is in making no notes which permit us to estimate the "factor"

by which their observations should be corrected to correspond to perfect observing conditions. For observations made from indoors, no comparable factor can be given; but for all observations made out of doors, comments on the condition of the sky should be made on each record sheet, including, if possible, careful estimates of the area obscured by clouds and of the magnitude of the faintest stars which are clearly visible.

A fourth error is in reporting only selected kinds of meteors—only bright ones, or only those belonging to a particular radiant. It is highly desirable to have the shower meteors separately counted, but the report should also state the total number of meteors seen, regardless of their class.

Ignoring these instructions does not save the observer any trouble: he has been out just as long and worked just as hard as others; but his results drop in value to a low per cent of what they should be. If accurate rates and corrected rates could be derived from the reports received, our table would not look like a checkerboard, with gaping spaces, but each line would be complete. The only exceptions would be corrected rates for observations made with sky conditions (e.g., clouds, moonlight, haze) so bad that the factor is less than about 0.5. The correction is then so uncertain that we prefer not to list the corrected rate.

It is an ungracious task to call to account persons who give of their time and labor cheerfully and without reward except the satisfaction of advancing science. We appreciate all they do, and we are not asking for *more* work, only for work done in such a way that it will be most valuable. We sincerely thank them and commend them for their enthusiastic support.

Observer and Station	Date 1936	Began	Ended	Total	Met.	F.	Rate	Cr.R.
(*1) Russell Anderson, Chicago,	July 29	14:10	15:30	80	7	1.0	5.2	5.2
Ill.	Aug. 11	13:15	15:35	140	15	..	6.4	..
Beatrice Angevine, Hydeville, Vt.	9	10:30	11:00	30	7	..	14.0	..
(*2) J. L. Black, Cleveland,	11	13:50	15:20	90	5	..	..	..
(*3) Ohio	17	14:13	15:13	60	6	..	..	..
(*4) Edw. F. Bowman, Kansas City, Mo.	11	9:54	16:41	407	174	..	..	..
Phil F. Brogan, Bend, Oregon	12	11:30	12:30	60	14	..	14.0	..
G. Michael Bugarr, Eugene, Ore.	11	11:30	12:30	60	25	..	25.0	..
(*1) R. H. Combs, Toronto, Canada	11	10:00	12:10	130	15	1.0	6.9	6.9
(*1, 5) R. M. Dole, Scarboro Beach, Maine	July 27	10:20	13:32	192	54	..	..	..
(*1, 6) Scarboro, Maine	Aug. 11	8:20	13:26	306	105	..	..	..
Julian Graham, Salem, Oregon	11	12:00	13:00	60	73	1.0	73.0	73.0
	12	11:55	14:05	130	85	1.0	39.2	39.2
(*1) Gordon Green, Pittsfield,	July 23	9:24	13:30	246	15	0.3	3.7	..
(*1) Massachusetts	24	9:55	14:45	290	30	1.0	6.2	6.2
(*1, 7)	26	10:45	15:00	255	33	0.8	7.8	9.8
(*1)	31	12:45	15:25	160	19	0.4	7.1	..
(*87)	Aug. 9	9:44	14:23	279	35	0.5	7.5	15.0
(*88)	11	10:28	13:00	152	24	0.5	9.5	19.0
(*62)	17	9:45	13:30	225	32	1.0	8.5	8.5
(*8, 9) William E. Hand, Cape	10	10:20	11:00	40	19	0.8	..	..
(*9, 10) May Point, N. J.	13	11:15	13:00	105	28	0.8	..	..
(*11) Wm. L. Holt, Scarboro, Me.	July 28	11:17	12:42	85	7	..	..	..
David Hunter, Eugene, Ore.	Aug. 11	11:00	13:00	120	77	..	38.5	..
(*12)	12	12:00	14:00	120	138	1.0	..	..
(*1) Hideo Inouye, Lake Suwa,	10	13:50	14:30	40	7	0.2	10.5	..
(*1) Japan	11	13:35	14:35	60	18	0.7	18.0	25.7
(*1)	12	13:40	15:10	90	21	0.8	14.0	17.5
(*13) J. T. Kent, Russellville,	July 27	13:50	15:30	100	35	0.9	..	..
(*14) Arkansas	28	13:12	15:02	110	86	0.9	..	..
(*15)	Aug. 11	13:24	14:50	86	66	..	..	..

Observer and Station	Date 1936	Began	Ended	Total	Met.	F.	Rate	Cr.R.
(*16)	12	13:29	15:15	106	74	..	..	..
(*17) Mohd. A. R. Khan,	July 24	22:20	23:30	70	15	..	12.9	..
Begumpet, N.S.R., India	26	20:00	21:00	60	17	0.6?	17.0	28±
	27	20:45	21:30	45	18	..	24.0	..
(*18)	29	19:45	21:00	75	9	..	7.2	..
(*19)	Aug. 4	21:30	22:30	60	2	..	..	..
(*19)	9	21:30	23:00	90	6	..	..	..
(*19)	10	20:00	21:30	90	2	0.2?	..	..
(*19)	11	19:30	20:45	75	21	..	..	..
(*19, 20)		21:30	22:00	30	10	..	..	..
(*19)	12	20:30	21:30	60	7	0.3?	..	..
(*21) George P. Kirkpatrick	8	12:10	13:45	95	7	0.9	4.4	4.9
(*22) New York, N. Y.	9	12:07	14:55	168	15	0.8	5.4	6.8
(*23)	12	12:23	13:50	87	8	0.5	5.5	11.0
(*1)	17	12:05	13:10	65	2	1.0	1.8	1.8
Joseph Leerman, Baltimore,	July 29	12:55	15:15	140	16	..	6.9	..
Maryland	Aug. 12	13:40	15:45	125	15	..	7.2	..
(*24, 25) E. Loreta, Bologna,	July 25	21:00	1:55	250	74	..	17.8	..
(*26) Italy	26	22:00	1:55	200	88	..	26.4	..
(*27)	28	22:30	1:55	175	127	..	43.6	..
(*28)	29	24:00	2:25	125	66	..	31.6	..
(*29)	Aug. 8	20:30	21:25	50	11	..	13.2	..
(*30)	9	20:30	21:55	75	21	..	16.8	..
(*31)		24:00	0:55	50	30	0.6?	36.0	..
(*32)	10	21:00	0:25	50	22	..	26.4	..
(*33)	11	20:30	2:55	300	253	..	50.6	..
(*34)	12	20:30	2:55	200	162	..	48.6	..
(*35)	13	23:00	2:55	200	154	..	46.2	..
(*36)	14	20:30	1:25	250	100	..	24.0	..
(*37)	15	20:30	0:25	200	67	..	20.1	..
(*38)	16	20:30	23:25	150	47	..	18.8	..
(*39) Louisville Astronomical	9	10:00	11:30	90	12	0.8	8.0	10.0
(*40) Society, Louisville,	10	11:30	13:30	120	28	1.0	14.0	14.0
Kentucky					31		15.5	15.5
					22		11.0	11.0
					36		18.0	18.0
(*41)	11	9:00	10:30	90	25	..	16.7	..
(*42)		11:30	14:00	150	37	1.0	14.8	14.8
					47		18.8	18.8
					43		17.2	17.2
					55		22.0	22.0
					41		16.4	16.4
(*43)	12	10:00	10:30	30	5	..	10.0	..
(*44)		10:30	11:00	30	5	..	10.0	..
(*45) Franklin F. Marsh,								
Frederick, Md.	12	13:00	16:00	180	22	..	7.3	..
(*46) C. P. Olivier, Shadwell, Va.	11	12:55	16:25	210	46	0.4	13.1	33±
(*47) Farmington, Va.	12	8:	10:		12	..	6.0	..
(*48) Shadwell, Va.	12	11:35	16:07	190	61	0.7	19.3	27.6
(*49) P. O. Parker, Cohutta,	11	10:35	13:20	165	17	0.6	6.2	10.3
(*1) Georgia	12	10:35	14:30	235	52	0.7?	13.3	19±
J. Hugh Pruett, Eugene, Ore.	11	12:07	14:00	113	83	..	44.0	..
(*50)	12	12:00	14:00	120	104	..	52.0	..
Hope S. Pruett, Eugene, Ore.	11	12:07	14:00	113	91	..	48.3	..
(*51)	12	12:00	14:00	120	86	..	43.0	..
(*52) Claude H. Smith, Waterloo,								
New York	11	10:07	12:45	158	138	1.0	52.4	52.4
(*1) F. W. Smith, Glenolden, Pa.	July 24	11:10	14:50	220	21	1.0	5.7	5.7
(*1)	26	11:50	14:50	180	32	1.0	10.7	10.7
(*1)	Aug. 7	8:30	9:30	60	2	1.0	2.0	2.0
(*1)	8	9:00	10:30	90	5	1.0	3.3	3.3
(*1)	12	10:40	15:55	315	26	0.7	5.0	7.1
(*1)	17	11:30	14:30	180	21	1.0	7.0	7.0

Observer and Station	Date 1936	Began	Ended	Total	Met.	F.	Rate	Cr.R.
(*1) Albert E. Waugh, Storrs,	11	10:15	11:50	95	15	0.2?	9.5	..
(*1) Connecticut	12	12:20	15:45	205	27	1.0	7.9	7.9
(*1)	16	14:30	16:00	90	13	1.0	8.7	8.7
(*53) Balfour S. Whitney,	July 22	11:10	13:44	154	40	1.0	15.6	15.6
(*54) Norman, Okla.	23	11:20	13:00	100	23	1.0	13.8	13.8
(*55)	28	12:40	16:15	215	70±	0.4?	19.5±	..
(*56)	Aug. 7	10:25	13:15	170	22	0.6	7.8	13.0
(*57)	8	9:50	11:52	122	31	1.0	15.2	15.2
(*58)	9	9:08	12:18	183	52	1.0	17.0	17.0
(*59)	10	10:03	11:06	63	15	0.8	14.1	17.6
(*58)	12	8:55	11:55	180	51	1.0	17.0	17.0
(*56)	13	9:49	11:20	91	23	1.0	15.2	15.2
(*60)	14	8:47	11:40	173	41	1.0	14.2	14.2
(*61)	17	8:37	11:20	165	34	1.0	12.1	12.1
(*62)	18	8:30	11:00	150	26	1.0	10.4	10.4
(*63) Latimer J. Wilson, Nashville,	10	11:38	12:40	62	7	0.4	6.8	..
(*64) Tennessee	11	10:35	12:45	130	17	1.0	7.8	7.8
(*65)	12	10:35	13:51	196	23	1.0	7.0	7.0
(*66)	13	12:03	16:00	237	24	..	6.1	..
(*67)	14	11:32	14:30	178	19	1.0	6.4	6.4
(*1, 68) R. H. Wilson, Jr., Mount-	10	11:00	14:00	180	45	0.9	15.0	16.7
(*1, 69) tain Home, Texas	11	11:45	13:45	120	38	1.0	19.0	19.0
(*1)	15	8:50	11:20	90	12	1.0	8.0	8.0
(*1) Paul S. Watson, Sykesville, Md.	12	12:00	16:00	180	20	1.0	6.7	6.7
NON-MEMBERS:								
(*70) W. I. Barnholth, Akron, O.	Aug. 11	10:35	11:15	40	35	..	..	..
(*71) Howard W. Blakeslee,								
Lake Kezar, Maine	11	11:00	13:30	150	109	0.9	..	..
(*72) E. M. Brooks, Silver Lake,	July 28			120	3	..	1.5	..
(*74) New Hampshire	Aug. 9			90	18	..	12.0	..
(*73)	10			60	12	..	12.0	..
(*74)	11			150	40	..	16.0	..
(*72)	12			120	25	..	12.5	..
(*74)	13			30	3	..	6.0	..
(*72) Miss B. Brooks, Silver	9			45	5	..	6.7	..
(*74) Lake, N. H.	11			150	40	..	16.0	..
(*72)	12			90	16	..	10.7	..
(*72)	12			120	21	..	10.5	..
(*19) Clayton Curtis, Pittsfield, Mass.	11	11:14	14:00	160	26	0.5	..	..
Harrison Daub, station not reported	12	11:45	13:30	105	43	..	24.6	..
(*1.75) J. B. Field, Sykesville, Md.	12	13:00	14:00	60	8	1.0	8.0	8.0
(*76) Geo. H. Fentress, Nashville,	13	11:30	14:00	150	18	1.0	7.2	7.2
(*1) Tennessee	14	12:00	14:00	120	3	1.0	1.5	1.5
(*77) S. D. Hampton, Auburn, Ala.	11	10:00	12:00	120	69	1.0	34.5	34.5
(*1) Geo. E. Lambert, Dunlo, Pa.	July 24	11:30	12:38	68	28	1.0	24.7	24.7
(*1)	25	13:23	14:52	89	42	1.0	28.3	28.3
(*78)	28	10:52	13:30	158	66±	0.6?	..	..
(*1)	Aug. 9	9:53	11:58	125	23	1.0	11.0	11.0
(*1)	11	10:12	11:58	106	22	0.6	12.5	20.8
(*1)	12	8:40	12:45	215	49	0.8	13.7	17.1
(*1, 89)	15	9:53	11:01	68?	16	..	..	..
(*1, 89)	16	10:55	12:46	111?	12	..	..	..
(*1)	17	10:10	12:36	146	23	1.0	9.5	9.5
Miss B. Leerman, Baltimore, Md.	12	13:00	13:30	30	6	..	12.0	..
	13	16:00	16:30	30	3	..	6.0	..
W. D. Parsons, Towanda, Pa.	11	11:00	12:00	60	13	..	13.0	..
(*79) Alfred G. Reid, Chester	12	11:00	12:00	60	37	..	37.0	..
Springs, Pa.					32		32.0	
					26		26.0	
					23		23.0	
					23		23.0	
					22		22.0	
					22		22.0	

Observer and Station	Date 1936	Began	Ended	Total	Met.	F.	Rate	Cr.R.
(*1) Kenneth Richter and Alfred E.	9	8:45	10:55	130	26	0.9	..	..
(*1) Cox III, Bridgewater, Mass.	10	8:44	11:02	138	6	0.3	..	..
(*1)	11	9:26	10:30	64	3	0.1	..	..
(*1)	12	8:11	10:35	144	11	0.3	..	..
(*80) Joseph D. Truxton, Jr.,	8	10:30	14:30	240	87	..	..	..
Philadelphia, Pa.	11	15:30	17:00	90	10	0.2	..	..
(*81)	12	12:00	16:00	240	80	..	..	..
OREGON GROUP:								
(*82) H. B. Donahey, Bend	Aug. 12	11:00	11:30	30	7	1.0	14.0	14.0
(*82)	13	10:30	11:00	30	11	..	22.0	..
(*85) J. L. Hardin, Ilwaco, Wash.	11	9:15	10:00	45	22	..	29.3	..
(*86)	12	8:50	10:25	95	26	..	16.4	..
Mary McBride, Sherwood	10	11:00	12:00	60	19	..	19.0	..
	11	13:00	14:30	90	59	..	39.3	..
	12	12:00	13:00	60	20	..	20.0	..
Robert L. Rugh, Eugene	11	12:00	13:00	60	54	..	54.0	..
(*83, 84) Betty Jane Thompson,	10	12:16	13:40	84	38	..	..	..
(*84) Eugene	11	12:06	13:20	74	116	..	..	..
(*84)	12	12:11	13:30	79	136	..	..	..
(*84)	13	12:01	13:01	60	54	..	..	..
Fergus Wood, Eugene	10	11:00	12:15	75	9	0.4	7.2	..
	11	11:10	12:50	100	47	1.0	28.2	28.2

Notes

1. Plotted.
2. From E attic window, F = 0.5. All Perseids.
3. From E attic window, F = 0.9. All sporadic.
4. Sky fair, clouding at end. Notes on each meteor. 5 observers.
5. Observed with Wm. L. Holt. 36 Aqr.
6. Observed with Wm. L. Holt and D. Milne. 101 Perseids. Hazy thin scattered clouds; aurora.
7. Eight δ Aqr.
8. One plotted; 13 Perseids.
9. 2 observers; asst. Reed Knox, Jr.
10. Three plotted; 26 Perseids.
11. Two observers; asst. D. Milne. Both of these members also observed with R. M. Dole as reported under his name.
12. Count by group of 3. 22 non-Perseids; 35 paths plotted.
13. Two observers; assistant, Mrs. J. T. Kent. 25 paths plotted.
14. Two observers; assistant, Mrs. J. T. Kent. 35 paths plotted; many faint meteors.
15. Three observers; assistants, Mrs. J. T. Kent and Frank Eddy. Sky poor: Moon, haze, cirrus clouds; 46 paths plotted.
16. Three observers, as in note 15. Sky poor. 52 paths plotted.
17. All times for Khan's report are U. T.
18. δ Aqr.
19. Count of Perseids *only*.
20. "The maximum of the shower must have occurred in the early hours of Aug. 12, U.T."
21. Six plotted.
22. Nine plotted.
23. Four plotted.
24. All times for Loreta's reports are G.M.T. To reduce to his standard time, add one hour; to reduce this to the usual A.M.S. time, then subtract 12 hours. The date refers to the beginning time; this makes the dates analogous to the others in the table.
25. Fifteen Aqr.; 13 Pers.
26. Twenty Aqr.; 20 Pers.
27. Forty-three Aqr. (probably maximum of shower); 37 Pers.
28. Twenty-one Aqr.; 18 Pers.
29. Three plotted; 6 Pers.
30. Nine plotted; 11 Pers.
31. Eighteen Pers.
32. Three plotted; 11 Pers. Obs. poor because of clouds.
33. Sixteen plotted; 181 Pers.
34. Fifteen plotted; 113 Pers. Obs. interrupted by clouds.
35. Ninety-six Pers.
36. Six plotted; 46 Pers.
37. Three plotted; 20 Pers.
38. Three plotted; 15 Pers.
39. Count by M. Shapinşky; 3 plotted.
40. Counts, observers respectively Dixie Leon, W. L. Moore, E. Scifres, M. Shapinsky. 8 paths plotted by group.
41. Count by Dorothy Fleischman.
42. Counts, observers respectively W. L. Moore, Dixie Leon, E. Scifres, M. Shapinsky, J. V. Jefferson. 16 paths plotted by group. Max. apparently betw. 12 and 13 hours.

43. Observer M. Shapinsky; 2 plotted.
44. Observer W. L. Moore.
45. Coop. obs.; facing moon last hour. 13 Pers.; 15 paths plotted.
46. Passing cloud; haze; moon after 13 h. 23 plotted; 34 Pers.
47. Three plotted; 10 Pers.; intermittent observations.
48. Thirty plotted; 50 Pers.
49. Fifteen plotted.
50. Seventy-three Pers.
51. Fifty-nine Pers.
52. One hundred and four Pers.; many with trains.
53. Thirty-six plotted; 7 δ Aqr.
54. Nineteen plotted.
55. Fifty-seven plotted; observations valueless for rates because of cirrus clouds.
56. Twenty-one plotted.
57. Twenty-six plotted.
58. Forty-seven plotted.
59. Fourteen plotted.
60. Thirty-seven plotted.
61. Twenty-nine plotted.
62. Twenty-five plotted.
63. Two plotted.
64. Three plotted; 8 probable Pers.
65. Nine plotted; 19 prob. Pers.; one 30-sec. train recorded, with drift.
66. Four plotted; 20 Pers,
67. Two plotted; 14 Pers.
68. Twenty-nine Pers.
69. Thirty-one Pers.; one 5-min. train.
70. Notes on each; 5 observers, one recorder.
71. Two observers; assistant, Mrs. Blakeslee.
72. Observations before midnight.
73. Observations after midnight.
74. Includes observations both before and after midnight.
75. Observ. made with P. S. Watson.
76. Ten plotted; on both nights Fentress was assisting L. J. Wilson.
77. Forty-four Pers.; Pers. rate highest in last 15 min. of observation.
78. Thirty-six plotted; 4 observers; stopped by clouds.
79. Independent counts by members of group, most of them students at the Pennsylvania Academy. In addition to the counts given, lower ones were also reported—20, 18, 16, 15, 14, 12, 11, 10, and 9. The average rate was 18.6, but this is probably not the most reliable; the high rates of 37 and 32 are reported as being probably the most complete.
80. Mostly Pers.; 17 paths recorded; three observers.
81. Forty-nine Pers.; 2 to 5 observers.
82. Notes on each.
83. Counted between clouds.
84. Group of three observers; duplicate observations counted only once.
85. Detailed notes on some.
86. Plotted; a few others seen.
87. Twenty-three paths plotted; factor 1.0 except for moonlight, but moon rose before end of first hour.
88. Eighteen Pers.; 23 paths plotted; stars blotted out at times with haze.
89. Times are for first and last meteors.

The Louisville Astronomical Society is due for special praise because, though a group observed together, none of the above errors was made; hence their work is fully usable. The low rates they obtained mean (unless their sky was more affected by adverse conditions than they suspected) that the Perseids gave them a rather weak display.

One of the most complete sets of observations received this year is from E. Loreta of Italy. He too has neglected to give his factors, but judging from the high rates obtained, we believe that he must usually have had clear or very clear skies. However, his results will give us an excellent picture for the 1936 cross-section of the Perseid stream. Many of the Perseids he observed had trains which endured for several seconds. He counted the meteors in magnitude groups, and found the Perseids to be on the average slightly brighter than either Aquarids or non-Perseids, the mean magnitude being around 3. This observer is making a deservedly high reputation for himself in amateur astronomy, not only in meteors but also in variable stars. He was one of the early discoverers (if not the earliest) of Nova Lacertae. His work is becoming steadily more valuable to the A.M.S.

Many of our observers live in or near large cities. As the Flower Observatory itself suffers this fate, I can vouch for it that a meteor observer under such conditions never really has an F = 1.0 sky. This fully explains the low rates sent

in by some, even though they report the sky as "clear" or give a high factor.

When plotted meteors and radiants are considered, as well as rates, B. S. Whitney, for the past two years on our staff here, sent in the most complete report received. Not only is his per cent of plotted meteors very high, but his special training in this work makes his results of unusual value. Radiants deduced from his maps, and from those of others, must wait until a later paper. His results fully confirm rather low rates, though most of them are in hours before midnight, after which it is well known the rate rises. Some of the highest rates reported were counts by observers on the Pacific coast.

Meteor photography was undertaken during the Perseid epoch by G. Green, J. Graham, the Louisville Astronomical Society, J. H. Pruett, F. W. Smith, and L. J. Wilson. Not all the details are at hand.

Despite the criticisms expressed earlier, I feel that the work of the A.M.S. during this past summer was particularly good, and many valuable results are deducible from it. We have yet to receive the reports from at least two of our largest and most active groups. These will doubtless greatly add to the totals given here.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1936 October 14.

The Roseburg Meteor of May 8, 1936.

By J. Hugh Pruett

An extremely brilliant and noisy fireball appeared over western Oregon May 8, 1936, at 1:32 A.M., P.S.T. In spite of the early hour, it was widely observed. Windows and dishes rattled in many localities. Many persons were awakened by the intense light or by the detonation following. Some thought an earthquake had occurred. One woman in Roseburg described the sound as the "most horrible" she had ever heard.

The writer, as Pacific northwest regional director of the A.M.S., was able to start early at tracing this interesting fireball. A local daily telephoned the news shortly after 8:00 A.M., and took a statement requesting data from observers. This went out as an Associated Press dispatch and was widely used in the evening papers in the northwest.

Almost 50 observers from three states and the high seas responded. A few gave such definite data that no "follow-up" letters were needed. To some, compasses and clinometers were mailed with full instructions for their use. Others were put in touch with their local high school instructors who furnished instruments and instructions. Forestry men helped in other cases. Some had their own compasses and showed skill in their use.

The general conclusions arrived at from the study of the data are as follows:

The meteor was first sighted over a locality 20 or 30 miles east of Oakridge. From there it descended at a slope of about 30°, and in two or three seconds exploded twice and disappeared over a region 90 miles southwest of the appearance locality. It was so brilliant over part of its flight that it cast strong shadows at a distance of 150 miles. Many reported a bluish, enduring train.

During the four years that meteor tracing has been carried on in the Pacific northwest, nine big fireballs have been studied. While the accuracy of Professor Nininger's method of touring the region from which observations have been made has by no means been obtained, still it is certainly true that much very definite information may be gained by correspondence. One working on this soon learns that some people are very poor observers and reporters. On the other hand, one

may often tell after reading a very few lines in some reports that real information is to be found there and in follow-up letters.

In a region noted for so many distinctive mountain peaks, such as western Oregon and Washington, the disappearance point is often established by these definite landmarks. Several reporting on the Roseburg meteor mentioned the parts of certain mountains over which they saw the explosion. A woman 200 miles north of the end point saw it reach the horizon just as far to the right of the tip of Mt. Hood as the full moon was to the left. Calculation soon gave the direction. A man south of the disappearance saw it burst over the "west slope of Mt. Sexton." A man to the west showed familiarity with the use of a mariner's compass when he reported, "It touched a 10° hill in a direction ESE-¼E, needle due north." An army lieutenant at a CCC camp gave a compass reading on a hill to the northwest. Two weather bureau stations furnished what are considered accurate readings.

The moon was almost on the meridian for the majority of the observers. Several north of the fireball referred to its direction and angular distance from the moon. A man in Portland, 200 miles to the north, reported that Antares took on a bluish and greatly enlarged appearance just as soon as the meteor passed, and did not resume its normal aspect until sometime afterwards. Evidently the train crossed the star from his position. Calculation gave very definite data.

The most ingenious time calculation between sight and sound was made by a young man at Roseburg. He walked two and one-half blocks during the interval. The next day he repeated the walk and found it took him two minutes and 45 seconds.

The newspapers of our region have always been willing to help in the collection of data. Many, however, have hinted very strongly that they would appreciate final reports and tracing maps. Observers also want to know more about the fireballs they attempt to help with. The writer has felt that the requests of both the press and individuals are reasonable and has in every case tried to work up an approximate solution within three weeks. More time is sometimes required, especially in such cases as the great Alberta meteor of March, 1933. All the papers will publish the final reports. The larger ones are glad to print the plotting maps in addition.

The plottings are originally made on a large map on which the meridians are drawn and the towns are accurately placed. From each town giving an intelligent report, two arrows are drawn: (1) a solid arrow shows the direction the observer first saw the fireball; (2) a dotted arrow shows the direction of disappearance. The appearance arrows are not usually extended very far in order to avoid too much crossing with the disappearance arrows. The latter, especially from places within 100 miles from the end point, are drawn long and up to the general disappearance locality. There is no need of "fudging" to make the lines converge toward a certain small region. In well-reported fireballs, a large number of them will do so with almost uncanniness. Those, that do not, impress the reader with the honesty of the plotting. In the case of the Roseburg meteor, the convergence from all sides is very striking.

Finally the approximate projection of the meteor's path is drawn on the map. Many intelligent readers could draw these themselves after studying the appearance and disappearance arrows. At first a very wide arrow was used on the maps for this path. Three years ago the artist of the *Portland Oregonian* changed this form of representation for the Yakima meteor to a comet with the head at the disappearance point and the tail stretching out over the estimated visible projected

path. This was so pleasing to the original plotter that he has used this form in all later cases.

The method of plotting mentioned above is not to be taken to indicate the usage in general in the A.M.S. The writer is not familiar with the methods used by regional directors elsewhere in the United States and Canada.

The following solution has been carefully worked out by Dr. Olivier:

Began over	$\lambda = 122° 11'$	$\phi = 43° 45'$
Ended over	$\lambda = 123\ 20$	$\phi = 42\ 45$
Ground point	$\lambda = 123\ 24$	$\phi = 42\ 40$
Local Sidereal Time at Ground Point		249°.8
Beginning Height		55 km
End Height		4 km
Length of Path		154 km
Projected Length of Path		146 km
Radiant ..... $a = 221°$ $h = 19°$	$\alpha = 1°.3$	$\delta = +48°.2$
Zenith correction (parabolic)		1°.6
Corrected Radiant $a = 221°$ $h = 17°.4$	$\alpha = 3°.6$	$\delta = +47°.1$
Orbit (parabolic) $i = 55°.0$, $\Omega = 47°.6$, $\pi = 146°.5$, $q = 0.58$		

Contributions from the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD, President, *and* H. H. NININGER, Secretary

The Spectra of Meteorites*

By ARTHUR S. KING†

Three methods of analysis are employed in finding the composition of terrestrial minerals, and can be applied to meteorites as well. First, chemical analysis, which determines the elements present and their relative amounts, but as a rule not their compounds. Second, the very beautiful method of mineralogical analysis, by which, often with the aid of a polarizing microscope, the compounds in the pulverized material are recognized through their crystal structures, and by a special attachment the crystals are counted and their relative abundance measured. Third, the method of spectrum analysis, in which the substance is vaporized in one of the laboratory sources, usually the electric arc or spark, and the chemical elements identified by the wavelengths of their spectrum lines. This method may be made closely quantitative by means of comparison spectra given by electrodes containing known amounts of the elements in question, the intensity of the spectrum lines being measured photometrically.

Very minute quantities of an element, of the order of one part in a million and sometimes much less, can be detected spectroscopically if the conditions of the source are favorable. Much depends, however, on the matrix material and also on the type of spectrum. If the energy required to produce the most persistent lines (arising from the lowest energy-level in the atom) is concentrated in a very few lines, as in the case of sodium, the spectroscopic sensitivity may be very great. When, however, this energy is divided among a considerable number of lines, as in

*A summary, with some additional material, of an invited paper read before the Fourth Annual Meeting of the Society at the University of California at Los Angeles, June 23 and 24, 1936.

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the complex spectra, the possibility of detecting very small amounts becomes correspondingly less.

The work to be reported on was carried out in order to determine the usefulness of spectrum analysis in supplementing the other methods, as well as to study a collection of meteorites most of which had not been examined spectroscopically. In order to make the data somewhat more than qualitative, I have attempted, in addition to the identification of elements, to indicate their relative abundance as shown by the strength of the more persistent lines and the degree of development of the spectra.

Specimens of the following meteorites, named after the locality of the fall, have been examined:

Irons

Canyon Diablo, Arizona
Mt. Joy, Pennsylvania
Staunton, Virginia
Xiquipilco [or Toluca], Mexico

Stones

Pasamonte, New Mexico
Sioux County, Nebraska
Allegan, Michigan
Ulysses, Kansas
Gruver, Texas
Richardton, North Dakota
Weldona, Colorado
Tryon, Nebraska

Graphite Nodule

Elden, Arizona

The arc was regularly used as a light source, though some spectrograms were made for the spark and the carbon-tube furnace. In using the arc, the lower carbon electrode was charged with fragments or powder of the meteorite. The spectrum of blank carbons, usually those used afterward with meteoritic material, was photographed on the same plate. When of sufficient conductivity, as in the case of iron and graphite specimens, pieces of the meteorite were used as electrodes.

In order to expedite the identification of the spectrum lines, thousands of which are present in the arc spectrum of a meteorite, arc spectra of the more abundant constituents were photographed on the same plate. For iron meteorites, such comparison spectra were those of iron, nickel, and cobalt, and for stony meteorites, arcs of iron, chromium, manganese, calcium, and magnesium were used. From these spectra a great part of the meteoritic lines, perhaps 99 per cent, could be identified by inspection. Those not identified at once in this way either belonged to elements having relatively few lines, such as sodium, aluminium, or silicon, or were the most persistent lines of elements present in very small quantity. In either case they were readily identified by means of tables giving the stronger lines of all elements. The spectrograms, made with a 15-foot concave grating, covered the range from λ2500 to λ6750. Three meteorites were examined also in the infra-red.

The elements detected in iron and stone meteorites are listed in the following table, with numbers designed to give some measure of the abundance of the element in each type. Thus "1" indicates that the most persistent lines were visible, and "5" that the spectrum was developed so fully as to indicate a high content of the element. In assembling the data, a tabulation of this sort was made for each

meteorite, but among meteorites of the same type the variations for most elements were found to be small. The abundance given is that usually prevailing, although the range of differences is noted in the case of individual irons or stones. Even meteorites quite different in appearance and hardness, such as the Pasamonte and Weldona stones, showed very similar spectra, a fact to be explained probably by the presence in the two varieties of different compounds of the same elements.

TABLE I

Estimated Abundance of Elements in Meteorites

	Li	C	Na	Mg	Al	Si	P	K	Ca	Sc	Ti
Irons	1	*	1	2	2-3	3	1	1	2	—	1
Stones	2	*	5	5	1-4	3-5	?	3	4	1	2-3

	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge
Irons	1	1	1	5	3	5	3	1	2	2
Stones	1	4	4	4	1-2	1-3	2	1-	1	1

	Rb	Sr	Mo	Ru	Ag	Sn	Sb	Cs	Ba	Au	Pb
Irons	—	1	1-	1-	1	1	1-	—	1	1-	1
Stones	1	1	—	—	1	—	—	1-	1	—	1-

*Usually masked, owing to the use of carbon electrodes.

As is well known from other analyses, the typical iron meteorite is an iron-nickel alloy; but the spectrum shows the presence, in relatively small amounts, of many other elements. Chromium and manganese, whose spectra are usually prominent in terrestrial irons, show their most persistent lines very faintly. The most notable rare elements are gallium and germanium, the strength of whose lines indicates a remarkable percentage of two elements which are very scarce in the earth's crust, though found in some igneous rocks. Gallium was detected in the early spectroscopic analyses of meteorites, and its occurrence in these bodies was taken as evidence of its probable presence in the sun, the gallium lines in the solar spectrum being at that time difficult of detection on account of blends. Germanium is often associated with aluminium in minerals,[1] and on this account is liable to be masked in chemical analysis. Other rare elements showing their stronger spectrum lines were scandium, rubidium, and caesium.

Metals of the platinum group have been the subject of frequent chemical analyses of the Canyon Diablo irons,[2] and have been found in very small amounts. Ruthenium, recognized by a faint line, was the only one detected in my spectrograms. The most distinctive line of platinum, λ3064.71, would have been concealed by a strong nickel line.

The stone meteorites show very intense spectra of magnesium and sodium, with those of calcium, silicon, chromium, and manganese following closely. The *D* lines of sodium (6 A. apart) were sometimes observed to spread over a range of 60 A. As sodium, according to chemical analysis, is much less abundant than magnesium in meteorites, this high intensity is due probably to the concentration of spectral energy in a few lines.

Of the stony meteorites examined, the Pasamonte, Sioux County, and Allegan specimens were of much more crumbly material than the others. Such friable stones gave stronger spectra of silicon, aluminium, and calcium. The Pasamonte and Sioux County stones showed only faint traces of the nickel and cobalt spectra,

[1] Goldschmidt, *Proc. Roy. Inst.*, **26**, 73, 1929.

[2] See summary by J. L. Howe, *Science*, N. S., **66**, 220, 1927.

which in the harder stones were well developed. This fact is of interest in connection with the hypothesis of G. N. Lewis,[3] if we consider the softer stones as representing the most advanced stage of the stone-forming process. According to Lewis's view, the differences in composition of iron and stone meteorites may result from the atomic disintegration of iron and nickel into silicon, aluminium, calcium, magnesium, and oxygen—all prominent constituents of the stones. Several of these transmutations have been produced in the laboratory. In addition, cobalt, fairly plentiful in the irons, has been found by Fermi and his co-workers[4] to change into manganese, an important constituent of the friable stones, in which cobalt is almost lacking.

However, the Allegan meteorite, a very friable stone, showed nickel and cobalt lines of fair strength, indicating a content in agreement with the chemical analysis of this stone by Merrill and Stokes.[5] The question of nuclear changes is therefore quite open, and requires a study of a large number of stony meteorites.

The Eldon meteorite, a specimen of which was supplied through the kindness of Mr. L. F. Brady of the Museum of Northern Arizona at Flagstaff, was described by him.[6] It is composed largely of carbon in the form of graphite (46.5 per cent[7]), which forms a matrix crossed by numerous intersecting veins made up chiefly of nickel-iron. As it was found about 35 miles from the Meteorite Crater in Arizona, Mr. Brady suggested that it might have been an inclusion in iron belonging to the Canyon Diablo fall, the iron shell having fallen away. Evidence supporting this view was given by R. E. S. Heineman,[8] who found a very similar, though smaller, nodule imbedded in a section of Canyon Diablo iron. The spectrum showed strong bands of the CN molecule in the arc and lines of ionized carbon (C II) in the spark. Aside from this evidence of high carbon content, the Elden spectrum was mainly of iron and nickel and very similar to that of Canyon Diablo iron. Exceptional features, however, were stronger spectra of the alkali metals and earths, especially barium, than is usual with irons.

At the writer's request, Professor F. A. Jenkins, of the Department of Physics of the University of California, Berkeley, tested the Elden graphite for the relative abundance of the isotopes of carbon (C^{12} and C^{13}) by the method previously used by him for the study of carbon isotopes in methane. A photometric comparison of the isotope bands from the meteoritic and from terrestrial graphite showed no difference in the relative abundance greater than the error of measurement. Details of this test will be given in the December, 1936, issue of the *Publications of the Astronomical Society of the Pacific*.

A comparison with the very exhaustive chemical investigation of meteorites by Ida and Walter Noddack,[9] in which abundances of a few parts per million and sometimes even less, were detected in mixtures of material from many meteorites, showed a fairly close agreement with the spectroscopic amounts given in the preceding table, and the same relations of abundance of each element in irons and stones. Elements found by Noddack and Noddack to be present in amounts greater than a few parts in a million, but not listed in my table, are gases such as

[3] *Phys. Rev.*, **46**, 897, 1934.
[4] *Proc. Roy. Soc.*, **146**, 483, 1934.
[5] *Proc. Wash. Acad. Sci.*, **2**, 41, 1900.
[6] *Amer. Jour. Sci.*, **21**, 173, 1931.
[7] Analysis by W. A. Sloane, U. S. Bureau of Mines.
[8] *Amer. Jour. Sci.*, **23**, 417, 1932.
[9] *Naturwissenschaft*, **18**, 757, 1930.

oxygen and chlorine or substances like sulphur whose persistent lines are in an inaccessible spectral region.

Meteoritic elements which are really abundant are well within the first third of the atomic-number series, nickel, number 28, being the heaviest plentiful element. A similar condition holds for elements in the earth's crust, but owing to a relatively higher terrestrial abundance of a few heavy elements, the predominance of the lighter elements is more pronounced for meteorites. In the case of compounds, it is well known that some constituents of meteorites are not found in the earth's crust. Noddack and Noddack found that for individual elements there is a higher abundance of magnesium, iron, and nickel, as well as of the rare elements gallium and germanium, in meteorites than in terrestrial rocks.

From the foregoing spectroscopic examination, it is evident that the chief field of usefulness of the method lies in the study of the less abundant elements. Fully half of the elements shown by the spectrum are not as a rule found in analyses by other methods. While it is possible to detect these elements in many cases by chemical reactions, the processes are usually difficult. For a quantitative spectrum analysis, a very small amount of the meteoritic material is sufficient, and when comparison spectra, made with electrodes containing standardized amounts of various elements are at hand, the analysis can be made in much less time than by the other methods.

Carnegie Institution of Washington,
Mount Wilson Observatory, Pasadena, California, September, 1936.

Relationships between the Structure and the Composition of Iron Meteorites*

By John Davis Buddhue

It was pointed out by Farrington[1] that the width of the kamacite bands in octahedrites depends upon the amount of nickel present, and that the greater this amount, the finer the structure. He indicated further that the hexahedrites seem to represent the limiting case in which the whole meteorite is kamacite. In the following table, I give Farrington's figures for the iron content of meteorites in relation to the width of the kamacite bands. I give also the nickel content as calculated by myself, and by Doelter.[2] The slight variation is due no doubt to differences in the material used.

Class	Width of bands	% Fe	% Ni	
			Author	Doelter
Hexahedrites	.....	94.12	4.99	5.05
Coarsest octahedrites	2.5 mm. and over	93.18	6.00	6.01
Coarse octahedrites	2.0 to 1.5 mm.	92.28	6.97	6.87
Medium octahedrites	1.0 to 0.5 mm.	90.64	7.47	7.89
Fine octahedrites	0.4 to 0.2 mm.	90.18	7.88	8.59
Finest octahedrites	0.2 mm. and less	88.51	8.24	10.42

The composition of kamacite may be regarded as pretty well established, not only on analytical grounds,[3] but also on the basis of the provisional iron-nickel diagram. This composition is $Fe_{14}Ni$, apparently an intermetallic compound of iron and nickel. Taenite is less well established, since the analyses collected by

*Read before the Fourth Annual Meeting.

[1] *Pub. 120 of the Field Columbian Museum*, p. 106 (1907).

[2] *Handbuch der Mineralchemie*, Band III, 2 Hälfte, p. 608 (1926).

[3] Farrington, *Meteorites*, p. 132 (1915).

Farrington[4] show an exceedingly variable composition, ranging between the extremes of FeNi and Fe_2Ni. A majority of the anaylses lie between Fe_2Ni and Fe_3Ni, and the latter formula corresponds also to the average of the 22 analyses cited by Farrington.[4] The only other support for this composition that I can find is that of the taenite separated by Davison[5] from the Welland, Welland County, Ontario, Canada, meteorite. The small size of the taenite bands which he obtained from the plessite of this meteorite, seemed to indicate considerable purity, for reasons which will appear later. The iron-nickel diagram indicates a composition of about 34% nickel, and this is supported by the fact that the conductivity of iron-nickel (and also iron-cobalt) alloys, reaches a maximum at about this point. Furthermore, the so-called irreversible transformation of the iron-nickel alloys ends at 34.4% nickel. It seems likely, therefore, that a compound corresponding to Fe_2Ni exists, or at least that something important is connected with this composition.

The variation in the analyses cited by Farrington can be explained by supposing that the taenite analyzed was not pure but consisted of a mixture, or eutectoid, of a nickel-rich alloy (probably Fe_2Ni) and kamacite. Tschermack and others noted long ago that under high magnification, taenite seems to have a duplex structure. This conclusion has recently been confirmed by J. Young.[6] The pure nickel-rich alloy might be called *orthotaenite,* while the impure mixture might be called *metataenite,* or just plain *taenite.*

Plessite is unquestionably a eutectoid of kamacite and taenite. Davison's separation of plessite into these two constituents[5] leaves small doubt on this point. Its duplex nature can be observed also in many others, such as San Angelo, Texas, Toluca, Mexico, and in parts of Canyon Diablo, Arizona. The laphamite structure described by J. L. Smith[7] in the Trenton, Wisconsin, meteorite, is doubtless another manifestation. Under the microscope, plessite can be seen generally to duplicate the Widmanstätten structure more or less imperfectly and on a much smaller scale. There is no difficulty in accounting for the structure of plessite, for eutectoids are of common occurrence, and are to be expected under certain conditions.

The origin of the Widmanstätten structure is an old problem which is not completely answered even today. The iron-nickel diagram in its present form is not very enlightening. It is known, however, that the structure must have resulted from the breaking-up of a homogeneous solid solution during the cooling process. It is the mechanism of this change that interests us.

X-ray studies have shown that both taenite and the γ-phase have a face-centered cubic lattice, while kamacite, like α-iron, is a body-centered cubic. Moreover, it is found that the (110) planes of the kamacite are nearly parallel to the (111) planes of the γ-phase.[6] These are the planes in the two systems in which the atoms are most closely packed, and they differ from each other only slightly (2% in atomic spacing or 4% in concentration of the atoms), so that the shift necessary to convert one form into the other is very small. As a result of these minor changes, a crystal of kamacite a few planes thick, but of considerable area, can separate on cooling. Extension in its own plane is easily accomplished, although an increase in thickness is attended by greater difficulty. This process is

[4] *Op. cit.,* p. 134.
[5] *Am. Jour. Sci.,* 3rd Ser., **42**, 65 (1891).
[6] *Proc. Roy. Soc. Lond.,* Ser. A., **112**, 630 (1926).
[7] *Am. Jour. Sci.,* **47**, 271 (1869).

complicated somewhat by the fact that the kamacite contains less nickel than the parent solid solution, and nickel does not diffuse readily in these alloys. The octahedral arrangement of the kamacite crystals arises from the fact that the (111) planes are those of an octahedron.

The fact that kamacite is poorer in nickel than the parent solid solution gives rise to the border of taenite, for, although nickel diffuses slowly, a certain amount of diffusion does take place. This results in an accumulation of nickel at the borders of the kamacite. That a certain amount of diffusion does take place is shown by the relatively constant composition of kamacite. The taenite itself is not pure orthotaenite, because, in many cases, there is not enough nickel to use up all the iron as Fe_2Ni and some is left over as kamacite.

The formation of the taenite layer is directly responsible for the relationship between the width of the kamacite bands and the nickel content. Once formed, the taenite layer forms an effective barrier against further growth of the kamacite crystals by isolating them from a sufficient supply of iron. Now the greater the nickel content of the original solid solution, the sooner a barrier of taenite will be set up, and so the kamacite bands will be small. On the other hand, if the nickel content is not large, no taenite barrier, or very few, will be formed, and the result will be a hexahedrite, or a very coarse octahedrite.

The brecciated structure may be the result of the formation of several crystals instead of a single one. The most important problem to be solved in connection with the Widmanstätten structure, is why most iron meteorites consist of single crystals, and why the Widmanstätten figures are as large as they are. All attempts to produce them artificially have resulted either in failure or in the formation of microscopic figures.

Other minor variations are the result of the action of minor constituents such as carbon, sulphur, phosphorus, copper, *etc.* It hardly need be stated that the orientation of rhabdites, troilites, and other substances arises in the same way as the orientation of the kamacite bands. In other words, some plane of the inclusion is parallel, or nearly so, to some plane of the solid solution.

The characteristic structure of the hexahedrites, namely the Neumann lines, is easily explained. It is known that iron readily twins, even when strained very slightly. The slip bands formed as a result of twinning occupy the same positions as the Neumann lines; hence there is little doubt that they are one and the same thing. It is not unlikely that the Neumann lines are formed by the impact of the meteorite when it strikes the earth.

The nickel-poor ataxites may result in two ways. An octahedrite may pass close to the sun or another star and become heated. If the heating is insufficient, or not continued for a long enough time, there will be a disturbance of only the octahedral structure such as the granulation of the kamacite seen in the Huizopa, Chihuahua, Mexico, meteorite. Continued, or intense heating, or both, will result in the complete destruction of the octahedral structure through granulation. The result will be an ataxite. Nickel-poor ataxites could be formed also under conditions unfavorable for the appearance of the Widmanstätten structure, or through an insufficiency of nickel.

The nickel-rich ataxites seem to be the result of a superabundance of nickel. Apparently too much nickel is detrimental to the formation of kamacite bands, and so the typical structure of ataxites results. The peculiar structure seen in the Hammond Township, St. Croix County, Wisconsin, octahedrites may be intermediate between those of the true octahedrites and the ataxites.

SUMMARY

The structure of the octahedrites arises during the cooling of a homogeneous solid solution. The (110) planes of the kamacite are parallel to the (111) planes of the original solid solution, and the two planes are almost identical in structure. Thus kamacite is easily formed and the resulting bands are parallel to the (111) faces, *i.e.* the faces of an octahedron.

The border of taenite is formed by diffusion of nickel from the kamacite, since kamacite contains less nickel than the original solid solution. Once formed the taenite greatly hinders the subsequent growth of the kamacite band. The greater the original content of nickel, the more quickly this barrier is formed, and as a result the fineness of the octahedral structure increases with the nickel content.

The variations in the analyses of taenite arise from the fact that it is a mixture of kamacite and a nickel-rich alloy. The composition of this alloy is unknown, but there is evidence to show that it is Fe_3Ni.

Hexahedrites consist entirely of kamacite and may be regarded as octahedrites with extremely wide kamacite bands. The Neumann lines are caused by twinning, possibly as the result of the impact at the end of the fall of these meteorites.

Ataxites may be: (1) octahedrites granulated by extreme or prolonged heating or both; (2) alloys with insufficient nickel, or the result of conditions unfavorable for the formation of Widmanstätten structure; or (3) alloys with too much nickel to show a regular structure. The Hammond structure may be intermediate between these and the structure of the octahedrites.

99 South Raymond Avenue, Pasadena, California.

New Committee Appointments

The following new committee appointments have been made by the President of the Society:

(1) A *Committee on Endowment,* consisting of Messrs. Dean M. Gillespie, Chairman, L. F. Brady, and O. E. Monnig, and the President and the Secretary-Treasurer, *ex officiis.*

(2) To the *Committee on Membership* (Mr. R. W. Webb, Chairman), Dr. H. C. Dake as an additional member.

Secretary's Office: Nininger Laboratory, 1955 Fairfax Street, Denver, Colorado.
Editorial Office: Department of Astronomy, University of California at Los Angeles.

The Image which Fell Down from Jupiter

By C. C. WYLIE AND J. R. NAIDEN.

In the account of the riot at Ephesus, the image of Diana (Artemis) is referred to as "the image which fell down from Jupiter." This translation of the passage in Acts 19:35 is that of the King James version. In popular books it is usually assumed, because of this passage, that the image of Diana was a meteorite, or that it stood on a meteorite. The following are typical quotations from some of the better known books:

Moulton, ASTRONOMY, page 297. "It is believed that the image of Diana, at Ephesus, the sacred shield of Numa, at Rome, and the image of Venus, at Cyprus, were meteorites."

Olivier, METEORS, page 3. "We have here evidence that the image was believed to have 'fallen from heaven' and what else could it have been but a meteorite."

Maunder, THE ASTRONOMY OF THE BIBLE, page 112. "Diana of Ephesus stood on a shapeless block which, tradition says, was a meteoric stone."

Gilbert, THE BIBLE FOR HOME AND SCHOOL, ACTS, page 186. "It was very probably a meteorite in some way resembling a female form."

On the other hand, in some books on the Bible the possibility of a meteorite is not even suggested. We are told that many cities had temples in which there were images or statues which the priests pretended, and the masses believed, had fallen from heaven. It was for the interest of the priests to keep up this impression. The image at Ephesus is described as "A block of wood carved roughly in the upper part into the shape of a woman, covered with paps to represent fertility."[1] This certainly is not the description of a meteorite. On the one hand we are told that the image at Ephesus was a meteorite. On the other hand we are told that the image at Ephesus was a carved wooden image, similar to others of that day which the priests pretended had fallen from heaven. To decide between the two versions, let us examine the evidence of classical languages, archaeology, and astronomy.

Let us look first at the passage in Acts in the original Greek. As we have said, the King James version gives the translation, "the *image* which fell down from Jupiter." The Douay version gives the translation, "Jupiter's offspring." The italics in the King James version signify that that particular word is not in the original, but supplied from the context. The actual Greek is του διοπετους, tou diopetous, both words being in the genitive singular. The first is the definite article. The second is an adjective, used in this passage as a substantive, or noun. The first three letters, διο, dio, are historically the same as the Sanskrit "dyaus," the Attic Greek "Zeus," the Ionic Greek "Dios," and the Latin "Iov-is," the genitive form of the word "Jupiter." The meaning of these words is originally "sky," and by extension they came to mean the "god of the sky," or any manifestation of the sky, as rain. The root, πετ, pet, occurring in the next three letters, means "fall," and is common in Greek. Therefore a literal translation would be, "that which fell from the sky." The translations which involve the word "Jupiter" are misleading, since, as we have seen, the word means "that which fell from the sky," or "from heaven," not "from Jupiter."

Dr. R. C. Flickinger, Professor of Classical Languages at the University of Iowa, suggests that the use of the word "diopetes" may not mean that any one believed the image of Diana at Ephesus had fallen from heaven. He assumes that the word was probably applied first to sacred objects believed to have actually fallen from heaven, but by extension, the word may in later centuries have become a sort of title of honor, applied to all sacred objects regardless of whether they were believed to have really fallen from the sky. Such extensions of use have been fairly common from early times to the present. In our day, the degree "Bachelor of Arts," as a title of honor, means something very different from the literal "artful bachelor." The degree "Bachelor of Science" is occasionally awarded to married ladies with very little training in science, about as far from the literal interpretation as possible. The word "annuity" is applied as regularly to monthly payments as to annual payments. We must keep in mind the possibility of such an extension of meaning in the use of the word "diopetes."

[1] Blunt, "The Clarendon Bible," page 227.

Let us now investigate the Greek use of the word "diopetes." On consulting the citations in the latest Greek dictionary, we find that it is used in passages that refer to statues and carved images. For example, in Euripides, I. T. 87 and I. T. 977, Orestes speaks of an image, "which men say fell into this temple from heaven." The commentators on I. T. 87, as well as elsewhere, tell us that throughout the Greek cities in classical times (4th century B.C.) there were many such images, carved out of wood, and of great antiquity, which were popularly believed to have fallen from heaven. In the encyclopedias of classical antiquity, both English and German, there are numerous articles dealing with these from-the-sky-fallen images, under the rubric of the various cities where they existed, and the deities represented. There is no suggestion that the temples contained any object other than the wooden image which the people believed fell from heaven.

Some commentators on the Book of Acts[2] tell us that a similar tradition appeared in later centuries in some Christian communities. It was believed that certain statues and paintings of the Virgin fell from heaven.

Let us now investigate historical references to the temple and the image of the goddess contained therein. The temple at Ephesus was one of the seven wonders of the classical world, and so there are many references. Vitruvius, the celebrated Roman architect, says (II 9, 13) that the image was made of cedar. Pliny the Elder, the noted scholar, says (XVI, 216) that the image was made of wood but of just which wood he is not certain, for although the image existed in his own time the accounts varied. Nearly all, he says, state that it was made of ebony, but Mucianus, the most recent of the writers who had seen it, says that it was made of vine wood. Although the masses probably believed that the image had fallen from heaven, the scholars knew that it was made by man. According to Pliny, Mucianus tells us that it was a man named Endaeus who selected the wood and made the image.

Let us now investigate the archaeological evidence. This alone shows over thirty places where the Ephesian goddess Artemis (Diana) was reverenced. The famous image was copied in little silver statuettes which are familiar to archaeologists. Presumably Demetrius, mentioned in Acts, made these copies of the image.[3] Copies of the image are also shown on coins from many periods. These statuettes and images on coins vary in the different periods, but agree on the essentials. According to Frazer,[4] they represent the goddess with a multitude of protruding breasts. The heads of animals of many kinds, both wild and tame, spring from the front of her body in a series of bands that extend from the breasts to the feet. The animals that thus appear to issue vary in the different copies, but include lions, bulls, stags, horses, goats, rams, and bees. The goddess was the symbol of exuberant fertility, or prolific motherhood. She was an Oriental deity representing the fecundity of nature. She was not the athletic and graceful huntress of Greek mythology.[5]

We have said that the little silver statuettes of Artemis (Diana) of Ephesus are familiar to archaeologists. A photograph of one of these is reproduced here. The finish and technique show that this statuette was made at a later date than the original image at Ephesus, but it shows the essential points on which, as we have said, the statuettes from the different periods agree.

Let us now consider the suggestion that the wooden image of the goddess was

[2] Lake and Jackson, Volume IV, page 250, and other commentaries.
[3] Lake and Jackson, Vol. IV, page 246.
[4] Frazer, "The Golden Bough," Vol I, part 1, page 37.
[5] Foakes-Jackson, "Acts of the Apostles," page 181.

resting upon a stone or other object of meteoric origin (or thought to be of meteoric origin). We have seen that the Greek word used in Acts 19:35 suggests

DIANA DI EFESO
(Palazzo dei Conservatori, Rome)

that the wooden image itself was believed to have fallen from heaven, but it carries no suggestion that any other object in the temple was believed to have fallen from

heaven. None of the descriptions of the temple, such as that of Pliny, suggest that there was anything remarkable about the foundation of the statue; neither do any of the statuettes. None of the descriptions suggest that the temple contained anything which the priests claimed had fallen from heaven, other than the wooden image of the goddess. As a matter of fact, the author of Acts is the only ancient writer who implies that the image of Artemis at Ephesus was believed to have fallen from heaven. It appears, therefore, that the meteoric base of the statue is the ingenious guess of some later writer. It is evidently designed to reconcile the use of the word "diopetes" with the fact that the image is known to have been an ordinary wooden statue. Since in the early writings and in the archaeological evidence no support has been found for this explanation, it must be rejected.

We have still to consider, however, the origin of the idea that sacred objects might fall from heaven. It appears that in classical times this claim was quite generally made, or the word "diopetes" used, for carved wooden images of great antiquity, such as the image at Ephesus. Human nature being what it is, however, we can safely assume that if the priests of one temple made the claim that their image fell from heaven, those of other temples would eventually be making the same claim. The real question is merely the probable origin of the tradition. We are told[6] that the image of Aphrodite (Venus) in the sanctuary at Paphos was simply a white cone or pyramid; that the emblem of Astarte at Byblus was a cone; and that the image of Artemis (Diana) at Perga in Pamphylia was also a cone. We are told that the image of the sun god, Heliogabalus, at Emesa in Syria was a cone of black stone with small knobs on it, and that it appears on coins of Emesa. We are told that the sacred stone of Cybele brought from Pessinus to Rome during the second Punic war was a small black rugged stone, but we do not know whether it was of conical shape. We are also told that conical stones, which were apparently considered sacred, have been found at Golgi in Cyprus, in the Phoenician temples at Malta, and in the shrine of the Mistress of Torquoise in Sinai. Frazer states that,[7] "the precise significance of such an emblem remains as obscure as it was in the time of Tacitus."

It is a well-known fact that the blunt cone is the most common and typical shape for meteorites. The images of many of these sacred stones are depicted on coins[8] preserved to our day. These images show that the stones were the shape of typical meteorites, and it is assumed by some scholars that many were genuine meteorites. In primitive times, as now, an occasional meteorite was seen to actually fall. The fall from the sky was naturally regarded as miraculous, and the stone was often placed in a shrine. The priests told the worshippers that this image was not made with human hands, but that it fell from heaven.

As sacred stones of later times one might mention the Casas Grandes meteorite found wrapped in a mummy cloth in a Montezuman ruin in Mexico; the Ensisheim meteorite which fell in Alsace in 1492, and was suspended in a church; and the sacred stone of the Mohammedans at Mecca. For the older sacred stones, there is now no way of telling which were authentic meteorites and which were not, but the shape suggests that several were. Of the stones preserved, the Ensisheim and Casas Grandes (an iron) are genuine meteorites. The stones found in Sinai are

[6] Frazer, "The Golden Bough," Third edition, Vol. I, pages 34-35.

[7] Frazer, "The Golden Bough," Vol. I, page 35.

[8] These coins showing sacred stones are called *Baetyl*, or Betyl, coins. Baetyl is from the same root as Bethel, but there is no reason for assuming that the stone at Bethel was a meteorite.

sandstone, and hence not meteoric, but they may be carved images of a genuine meteorite. The sacred stone at Mecca has not been examined.

When a stone was actually observed to fall from heaven, it was sometimes assumed by the people of Greece and Rome that it had been thrown from some volcano, as Vesuvius, even though the fall was observed at a great distance from the volcano. Excepting for this assumption, however, the fall of meteoric stones was probably regarded as miraculous, and the stones were considered sacred. These sacred stones really did fall from heaven. The transfer of the "from-the-sky-fallen" idea from the sacred stones to the sacred images of wood which were so ancient that the names of the makers were forgotten, was a natural step.

We suggest therefore that the tradition that sacred objects fell from heaven originated with meteorites seen to fall. For the Greek world the tradition probably originated with and was kept alive by the conical stones worshipped at various places, and depicted on numerous coins some of which are preserved to our day. This tradition was transferred from the stones in these shrines to the wooden images in various temples, such as that at Ephesus. It appears that the masses at first accepted this as a claim that these wooden images actually fell from the sky, but perhaps the term later came to be interpreted as merely a title of respect and honor. Pliny and Mucianus did not believe that this image of Diana had fallen from the sky, and perhaps the general public of their day had come to reject a literal acceptance of the claim. It is known that Ephesus was a very old city, and the temple at Ephesus was an ancient shrine. It is possible that in primitive times a meteoric stone was worshipped at Ephesus. We have found no record, however, of such a stone, and the first and only record of the tradition that the image at Ephesus fell from heaven is the relatively late account of the author of Acts. It appears, therefore, more probable that the term "from-the-sky-fallen" appeared at Ephesus only when it was in common usage at other temples with wooden images.

In conclusion, we have found that the Greek word "diopetes" indicates literally a tradition that the object of worship fell from heaven. We have found that this Greek word was commonly used in classical times for carved wooden images of great antiquity. We have also found that the image at Ephesus was of wood, and from silver statuettes preserved to our own time we know the appearance of the image. We have found no reason for assuming that anything in the temple other than the wooden image was believed to have fallen from heaven. The Greek word "diopetes," when first applied to the carved wooden images, appears to have been interpreted literally as a claim that the image fell from the sky. It is possible, however, that in the course of centuries, it had come to be regarded as merely a title of honor for sacred objects. The account in Acts, therefore, does not necessarily mean a belief that the image at Ephesus fell from the sky.

The tradition that sacred objects fell from the sky probably originated in ancient shrines where meteoric stones were worshipped. It is known that stones resembling meteorites in shape were worshipped in many places in classical times. The idea of falling from the sky would naturally be transferred from the sacred stones in these shrines to the sacred images of wood at Ephesus and elsewhere.

University of Iowa, September 2, 1936.

A Daylight Meteor

On the 21st day of December, 1935, when working in a peach orchard about 1½ miles south of Wheatland, California, about 3^{h} P.M., and in the sunlight as bright as it could be in this time of the year (clouds having been practically ab-

sent), I noticed a very bright meteor crossing the sky under the course approximately E.N.E., appearing first as an elongated, but short streak of very white smoke, then flaring up soundlessly into a green flash (a color similar to that of barium flame) and disappearing—all in about three seconds. I would not insist upon the phenomenon as strictly of meteoric origin, fireworks being possible after all, but for the direction of the streak and for the personal observation of a smoky meteor once before, at Tanuma, Mesopotamia, in the summer of the year 1921. This time, unfortunately, nobody noticed the meteor besides myself.

Yours very truly, V. V. YANKOVICH, *itinerant.*

(Mr. Yankovich sent no address and consequently the receipt of this communication could not be acknowledged. It is hoped that he will see it in print. ED.)

Notes from Amateurs

The Fourth Year of the Rhode Island "Skyscrapers"

The annual election and business meeting of the Skyscrapers Amateur Astronomical Society of Rhode Island was held in Wilson Hall, Brown University, on June 3, 1935. The following officers were elected: President, Mr. Harry A. MacKnight; Vice-Presidents, Mr. Franklin S. Huddy and Mr. Frederick W. Hoffman; Secretary-Treasurer, Miss Wilhelmina Null.

The program of the fourth year was as follows:

July 10, 1935. Outdoor meeting at the home of Mr. Frank P. Sherman, Johnston, Rhode Island.

July 20, 1935. A large delegation attended the Second Annual Convention of the Amateur Telescope Makers of Boston at Harvard Observatory, Cambridge, Massachusetts.

August 3, 1935. The Skyscrapers attended the Tenth Annual Convention of the Springfield Amateur Telescope Makers at "Stellafane," Springfield, Vermont.

August 12, 1935. Outdoor meeting at the home of Mr. Franklin S. Huddy, Chepachet, Rhode Island.

September 4, 1935. Mr. R. Newton Mayall of Boston spoke on "Sundials."

October 7, 1935. Rev. John G. Crawford told of his trip to the British Isles.

November 2, 1935. Visit to the Hayden Planetarium, New York City.

November 6, 1935. Professor Lunt of the Rhode Island College of Education gave an address on "The Teaching of Stars and Constellations."

December 2, 1935. Mr. Frederick W. Hoffman spoke on "The David Dunlap Memorial Observatory at Toronto."

January 1, 1936. Professor Charles H. Smiley of Brown University gave a lecture on "Minor Planets of the Solar System."

February 3, 1936. Dr. Harry L. Koopman, Professor Emeritus of Brown University, spoke on "The Man in the Moon."

March 4, 1936. Mr. Donald Prentice gave an address on "Around the Universe in Fifty Minutes."

April 10, 1936. Professor Anne S. Young of Mt. Holyoke College Observatory spoke on "How Far Away the Stars Are."

On May 12, 1936, the fourth annual dinner was held at Faunce House, Brown University. Following the dinner, over 150 members and guests of the Skyscrapers heard Mr. James Stokley, Director of the Fels Planetarium, Franklin Institute, Philadelphia, Pennsylvania, speak on "Famous Telescopes and Observatories I have Visited." He illustrated his lecture with lantern slides and motion pictures.

On May 23, 1936, the Departments of Astronomy and Physics of Brown University and the Skyscrapers Society held their first convention at Wilson Hall and

Ladd Observatory, Brown University, for a discussion of telescope making. Eighty-six amateur telescope makers from all over New England were present to hear the following program:

"Making and Using Replica Gratings,"
Mr. Harry A. MacKnight, President of the Skyscrapers.
"Uses of Polarized Light,"
Dr. C. W. Miller, Professor of Physics, Brown University.
"The Construction of a Schmidt Camera."
Mr. Donald S. Reed, Rhode Island School of Design.
"Aluminizing."
Dr. Alfred B. Focke, Department of Physics, Brown University.

Ladd Observatory was open to the visitors in the evening and the 12-inch refractor telescope was used to observe the new Peltier Comet and other interesting objects.

Mr. Donald S. Reed has finished the polishing of the spherical mirror for the Schmidt Camera and Mr. Harry A. MacKnight is setting up a very elaborate spindle for grinding and polishing the correcting plate for the same.

The Skyscrapers organization has been divided into several sections for special study this year. These sections include telescope making; meteors, comets, and variable stars; moon study; sun study; book reviewing; mathematical; planet study; constellation study; and photographic section.

John Bunyan's Observatory

As a consequence of an interest aroused in astronomy while he was a student in high school more than forty-five years ago, Mr. John Bunyan of Berthoud, Colorado, has recently built and equipped the observatory shown in the accompanying photograph. Mr. Bunyan started with an old-fashioned portable telescope having a 2-inch objective. The principal instrument in his present equipment is a 10-inch Cassegrainian mirror. This instrument is permanently set up in the usual way. It rests upon a foundation firmly built, and is mounted equatorially which makes it possible to use a driving clock.

Mr. Bunyan has several other auxiliary instruments, as well as a sidereal clock and a library of recent astronomical works, to assist him in his survey of the skies. The citizens of Berthoud are fortunate in having this astronomical equipment in their community, especially so since the owner of it generously states that visitors are welcome. The equipment is such as to reveal many objects which are invisible to the unaided eye and which, consequently, many persons never see. Through his observatory, Mr. Bunyan is making an important contribution to the pleasure and the culture of his neighbors and friends.

Amateur Astronomical Association of Pittsburgh

Mr. Leo. J. Scanlon, secretary-treasurer of this association and regional director of this district, was elected a member of the American Astronomical Society at its recent meeting held at Harvard University. This is a well-deserved recognition for Mr. Scanlon's activity in astronomical affairs.

Reverend F. J. Sullivan, O.S.F., is back with us after a vacation in New England. Mr. Sullivan is studying with Dr. Keivin Burns at Allegheny Observatory. Their research involves photographic work of the solar spectrum into the infra-red beyond limits heretofore attained.

At our first meeting of the year in September, N. C. Goin, one of our members who is associated with Westinghouse Electric and Manufacturing Company, gave an interesting talk on the 200-inch telescope mounting which will be made by his firm in Philadelphia. N. J. Schell told us of some difficulties which an amateur or professional may expect to encounter in making large aperture short-focus mirrors. Howard Dick has completed a portable grinding machine. Mr. Morgan Cilley came all the way from Romney, West Virginia, to pay us a short visit on October 1. On October 17, our group visited the Twin Elms Observatory as the guests of Maude S. Weigel.

F. M. GARLAND, *Vice-President.*

Asteroid Notes

By HUGH S. RICE

IRIS AND VESTA

During the present year, we find that the brightest asteroids now observable are 7 Iris (see chart in August-September POPULAR ASTRONOMY) and 4 Vesta. As observed at Rutherford on October 20, Iris was $7^M.7$ (0.7 of a magnitude fainter than predicted) so we can look for a magnitude of at best $7^M.5$ at the time of opposition, November 23. We hope to put a chart of Vesta's winter path in the next issue of this magazine. In the middle of November, Vesta will be around its stationary point, about $2\frac{1}{2}°$ nearly south of δ Geminorum.

OTHER ASTEROIDS

Among the other fairly bright asteroids now observable are 40 Harmonia ($9^M.1$) and 5 Astraea ($9^M.4$), in Taurus. Astraea will pass south of Aldebaran about December 9. Their ephemerides are:

EQUINOX 1925, 0^h U.T.

	40 HARMONIA			5 ASTRAEA	
	α	δ		α	δ
	h m	° ′		h m	° ′
Nov. 8	4 42.3	+18 3	Nov. 16	4 55.5	+13 54
16	4 35.0	17 58	24	4 48.6	13 35
24	4 26.4	17 53	Dec. 2	4 40.8	13 21
Dec. 2	4 17.3	17 49	10	4 32.9	13 12
10	4 8.5	17 46	18	4 25.2	13 10
18	4 1.0	+17 48	26	4 18.7	+13 16
Opposition Nov. 29; var. +3′.1			Opposition Dec. 3; var. +2′.3		

Hayden Planetarium, American Museum of Natural History,
New York City, October 21, 1936.

General Notes

Professor A. A. Nijland, director of the Observatory of Utrecht, died on August 18 at the age of sixty-seven.

Professor Felix de Roy, president of the commission on meteorites, zodiacal light and related phenomena, and director of the Variable Star section of the British Astronomical Association, was recently honored with the degree of Doctor of Mathematics and Physics by the University of Utrecht in recognition of his astronomical work. This honor was conferred in connection with the celebration of the tercentenary of that university.

Lick Observatory Bulletin, No. 483. This Bulletin consists of a fourth catalogue of spectroscopic binary stars and was prepared by Professor J. H. Moore. Table I lists the orbital elements of 375 stars of variable radial velocities, which had not been listed before. This brings the total number of such stars to about 1420. This Bulletin is a valuable addition to the literature of this subject.

The Rittenhouse Astronomical Society of Philadelphia held a meeting on Friday, October 9, at 8:30 P.M., in the Hall of The Franklin Institute. The program consisted of an address on the subject "Spinning Bodies," illustrated with demonstrations, by Dr. Richard M. Sutton, Assistant Professor of Physics, Haverford College.

At the November meeting, on Friday evening, November 13, Dr. Clyde Fisher, Curator of the Hayden Planetarium, New York City, will tell of his observations last June of the Siberian eclipse and his studies of meteor craters in Esthonia. This will be illustrated with original motion pictures.

A. CLYDE SCHOCK, *Secretary.*

New Variable Stars.—In *Discovery Bulletin,* No. 1, Mr. A. G. C. Crust of the New Zealand Astronomical Society, lists nine variables which have been discovered directly or indirectly through the employment of the method of measuring star colors. The stars are:

Beta Herculis	Gamma Serpentis	c Velorum
Zeta Herculis	Psi Velorum	Beta Cancri
Alpha Cancri	b Velorum	Pi Virginis

The periods of these stars as far as they have been determined range from two to forty-six days. The variation in magnitude is slight, the largest being 0.7 of a magnitude.

Book Reviews

Text Book on Spherical Astronomy, by W. M. Smart. (Cambridge University Press, London. $7.00.)

The present reviewer strongly recommends "Text Book on Spherical Astronomy," by W. M. Smart, to all students of mathematics and astronomy. A careful reading of this book would prove of inestimable value to the undergraduate college or university student preparing for graduate astronomical study.

The college student of mathematics will find in "Text Book of Spherical As-

tronomy" many revealing examples of the application of elementary mathematics to astronomy, and will be delighted with the lucidity with which many important and intricate problems of astronomy are explained. The book is unusual for one on spherical astronomy, in that it covers such subjects as heliographic coördinates, determination of position at sea, determination of star positions from photographs, and orbits of binary stars. For a good discussion of the basic principles of these subjects, the student had formerly to delve for himself in various astronomical publications. It is to be regretted that no discussion is given of the dependence method of reduction of photographic plates.

While some, having been taught in their youth that the south point is the origin for the measurement of azimuth, may object to Professor Smart's choice of the north point, and while others likewise may find here and there something to object to, all should concede that from the pedagogical point of view "Text Book on Spherical Astronomy" is excellent, and that it is well written and satisfactorily illustrated. R. S. Z.

Through My Telescope, by W. T. Hay. (John Murray, London. Price 3/6.)

This small volume, almost pocket-size, presents the elementary facts of descriptive astronomy in a simple and direct manner. The author proceeds in the customary way. He begins with the sun and works in ever widening circles until he reaches the most distant regions now known. The discussion is divided into nineteen chapters, each chapter being quite short, and consequently easily grasped. The author, being an enthusiastic user of his telescope, writes with a conviction and a clearness which comes from experience. The book can be recommended as a very suitable one for the beginner.

The author will be recalled by astronomers as the person who first noticed the white spot on the planet Saturn in August, 1933.

For the benefit of our readers, outside of England, we may state that the author is well-known in England for his humor on the theatre stage. It is somewhat unusual that a person having that as his vocation should have the study of the stars as an avocation.

Aristotle, Galileo, and the Tower of Pisa, by Lane Cooper. (Cornell University Press, Ithaca, New York. Price $1.50.)

Although the names in the title, and, indeed, most of those which appear in the text, are the well recognized names of ancient and modern scientists, the writer of the volume is a professor of English Literature. The reader will readily see, however, that the author has made effective use of his knowledge of literature in substantiating his thesis which is an exceedingly interesting one in the realm of science.

Perhaps there are no more dramatic events in the history of science than those which center around the name and personality of Galileo. The present volume questions the historical accuracy of some of the ideas which are currently held regarding certain of those events, notably the experiment relating to falling bodies, supposed to have been made from the top of the obligingly leaning tower of Pisa.

The reviewer will not presume to pass judgment on the authenticity of an incident so widely publicized, but will merely direct the reader to this volume where many passages in their original setting are presented, from which he may draw his own conclusions. The book is not a large one, but it is clear and intelligible in regard to the questions at issue. It is recommended as stimulating and instructive.